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ABSTRACT

This instructor's manual for workplace trainers contains the materials required to conduct a course in pre-statistical process control. The course consists of six lessons for workers and two lessons for supervisors that discuss the following: concepts taught in the six lessons; workers' progress in the individual lessons; and strategies for helping workers continue to develop the skills taught in the course. The following materials are provided: lesson plan, learning activities based on real-life situations, handouts, assessments (including pretests and posttests), and transparencies. Each lesson plan contains objectives, a list of materials needed, classroom setup information, and detailed instructions for conducting all activities. Lessons cover the following topics: learning and working together; arithmetic review; decimals and percentages; descriptive statistics; basic statistics; and control charts. (MN)

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ED 426 303

Pre-Statistical Process Control: Making Numbers Count!

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JobLink

Winning At Work

Math for Statistical Process Control

Making Numbers Count

- Learning and Working Together
- Arithmetic Review
- Decimals and Percents
- Descriptive Statistics
- Basic Statistics
- Control Charts

▼ An Introduction

Pre-Statistical Process Control (SPC) prepares workers to successfully participate in continuous process improvement initiatives by providing an understanding of key SPC concepts and how they relate to the quality worksite. Basic math concepts and principles are introduced to prepare the worker who may have limited numeracy skills for implementing SPC concepts.

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▼ Module 3 Materials

Materials	Lesson#
Overhead projector	All
Transparency markers	All
Scratch paper	All
Company's product catalog and/or advertising brochures	1
Company Organizational Chart	1
Memo from President or Vice President	1
Videotape on SPC (one we recommended is the Annenberg Foundation's videotape interview with Edward Deming)	1
Cusinaire rods	2,5
Calculators (one per student)	2,3,4
Cusinaire blocks and dice (at least one set for every three employees)	3
Wire abacus	3
Transparent cusinaire rods	3,5
Plastic or cardboard circle graphs (like pizza slices)	4
Large scissors	4
Construction paper	4
A balance with multiple hooks on each side	5
or	
A set of yardsticks or metersticks (1 for every 2 employees)	5
200 pennies (2 rolls)	5
Dice (2 dice per group)	6
A ball of string	6
A blindfold	6

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Lesson 1
Learning and Working Together

▼ Lesson Description

Group learning, interaction, and problem-solving are the main thrusts of this module. Throughout the lessons in this module, the instructor should encourage employees to work together and to help one another not only in the activities provided but also on the job and outside of the work environment.

The first lesson is designed to help employees begin to overcome their fears to speak their opinions. The lesson begins with an ice-breaker: The employees introduce themselves to one another and to the instructor.

This lesson also spurs employees to think about establishing positive connections between their private lives and their work lives. Class discussions begin, understandably, with job-related goals, but employees should be encouraged to expand their discussions to personal and community issues.

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▼ Objectives

By completing this lesson, employees will be able to:

1. **Become** acquainted with their coworkers and superiors.
2. **Describe** their jobs to the class, as well as the jobs that precede and follow in the normal progression.
3. **Describe** their specific roles and explain how they contribute to making the final product.
4. **Tell** why their company makes the products it does and explain the products value from the consumers point of view.
5. **Describe** the connection between their private lives and their work lives.
6. **Describe** the larger picture of their work environment.
7. **Explain** why Statistical Process Control (SPC) is important to the welfare of the company and how SPC contributes to their own job security.

▼ Materials Needed

▼ Forms

"PreTest"

"Learner Enrollment"

▼ Hardware

1. Overhead projector
2. Transparency markers
3. Companys product catalog and/or advertising brochures
4. Company organization chart
5. Memo from President or Vice President
6. Articles and videotapes on SPC and on Edward Deming *(one particularly good source is the Annenberg Foundations videotape interview with Edward Deming)*

▼ Transparencies

"Getting to Know You" (Transparency 1)

"My Job Is..." (Transparency 2)

"The Company Team" (Transparency 3)

▼ Materials Needed

▼ Handouts

"Getting to Know You" (Handout 1)

"My Job Is..." (Handout 2)

"The Company Team" (Handout 3)

▼ Classroom Set-up

▼ Total Time: 90 minutes

Opening- Large Group/Partners	25 min.
First Activity- Large Group	20 min.
Second Activity- Large Group	20 min.
Third Activity- Large Group	15 min.
Ending- Large Group	10 min.

▼ Key — Hardware | Transparencies | Handouts | Large Group | Small Groups | Discussion | Sign-in Sheet

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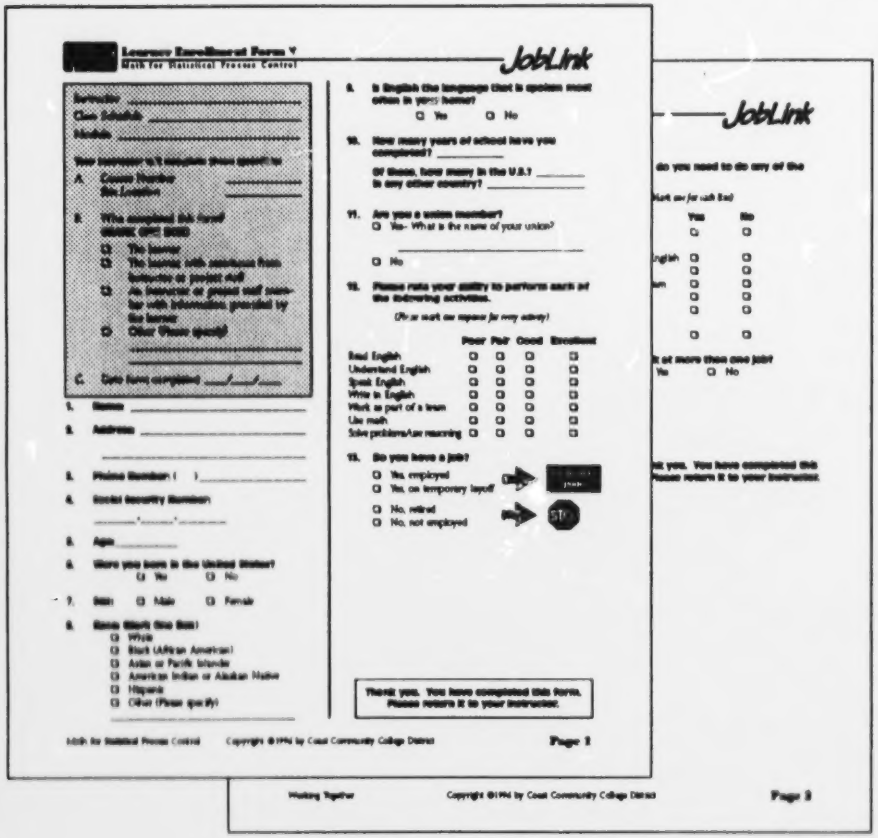
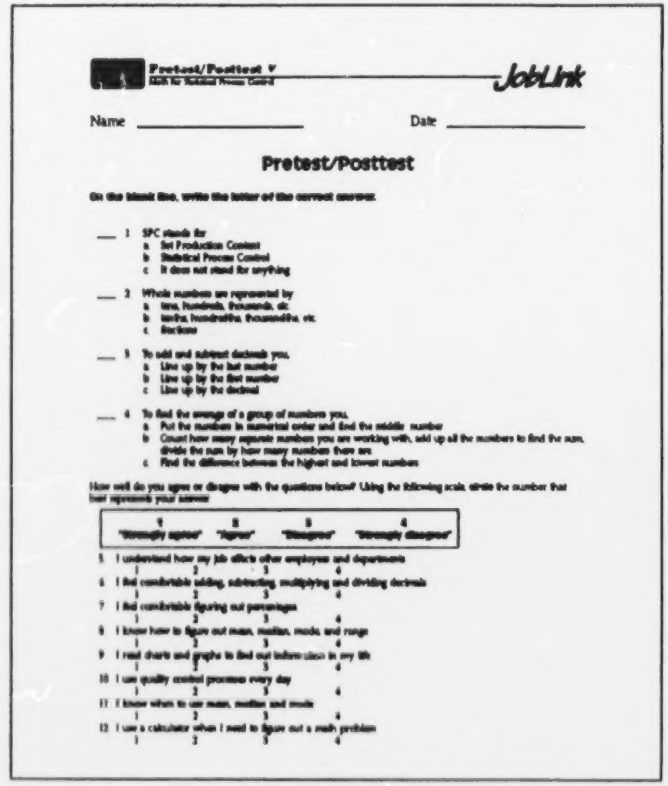


Learner Enrollment Form



Form

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▼ Activities

▼ Opening: 25 Minutes

1. **Welcome** employees. **Ask** them to fill out name tags. Have refreshments available if possible.

2. **Introduce** yourself. Briefly **tell** the class about your background, your hobbies, and your interests, as well as why you are working on this project.

3. **Explain** the general goals and objectives of the six lessons in the PRE-SPC module.

4. Have the students fill out "Learner Enrollment" form.

5. **Handout** "Pretest". **Explain** that they should do their best. **Explain** that you **do not** expect them to know the answers, and they will take this test again at the end of the module.

6. **Explain** that in this first exercise the employees will get to know their classmates. **Tell** employees they will work in pairs to interview one another; then each employee will introduce her or his partner to the rest of the class. **Encourage** them to speak up and to express themselves clearly. **Assure** employees that the exercise will be both informative and fun.

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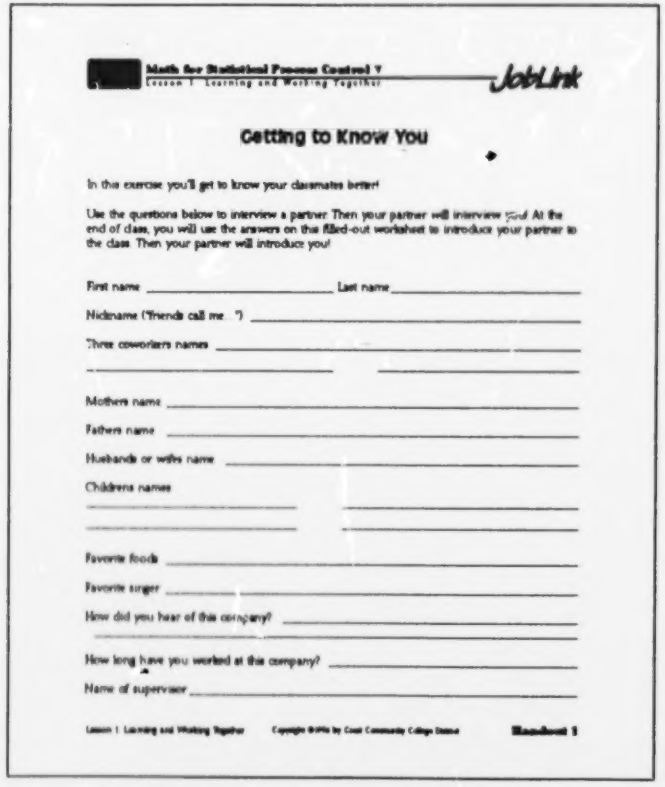

Math for Statistical Process Control ▼
Lesson 1: Learning and Working Together
JobLink

Getting to Know You

In this exercise you'll get to know your classmates better!

Use the questions below to interview a partner. Then your partner will interview you! At the end of class, you will use the answers on the filled-out worksheet to introduce your partner to the class. Then your partner will introduce you!

First name _____ Last name _____

Nickname ("Friends call me...") _____

Three coworkers names _____

_____ _____

Mothers name _____

Fathers name _____

Husbands or wifes name _____

Childrens names

_____ _____

_____ _____

Favorite foods _____

Favorite singer _____

How did you hear of this company? _____

_____

How long have you worked at this company? _____

Name of supervisor _____

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Handout 1, Transparency 1

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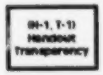
▼ Activities

▼ Opening: (continued)

7. **Group** employees into pairs. *(Note: If there is an odd number of employees, create one group of three partners.)*



8. **Distribute** "Getting to Know You" to each employee and **project** it on the overhead. **Explain** that the worksheet will help them to interview their partners.

9. **Demonstrate** how to complete the form:

   a. Choose an employee for the demonstration.
   b. Give that employee a copy of the worksheet, and ask her or him to begin interviewing you by asking the first few questions.

   Allow the class time to complete their interviews. *(Note: If you run short of time, tell employees they don't have to fill out every item.)*

10. Now **have** each employee introduce his or her partner as explained in the handout instructions. **Move** things along quickly, and **encourage** everyone to speak loudly. **Assure** them there is no reason to feel bashful! **Remind** them that this is a fun project a no-risk activity!

11. After introductions have been completed, **ask** the class: "What did you learn from this exercise? Do you have any suggestions for other questions? Any other improvements?"

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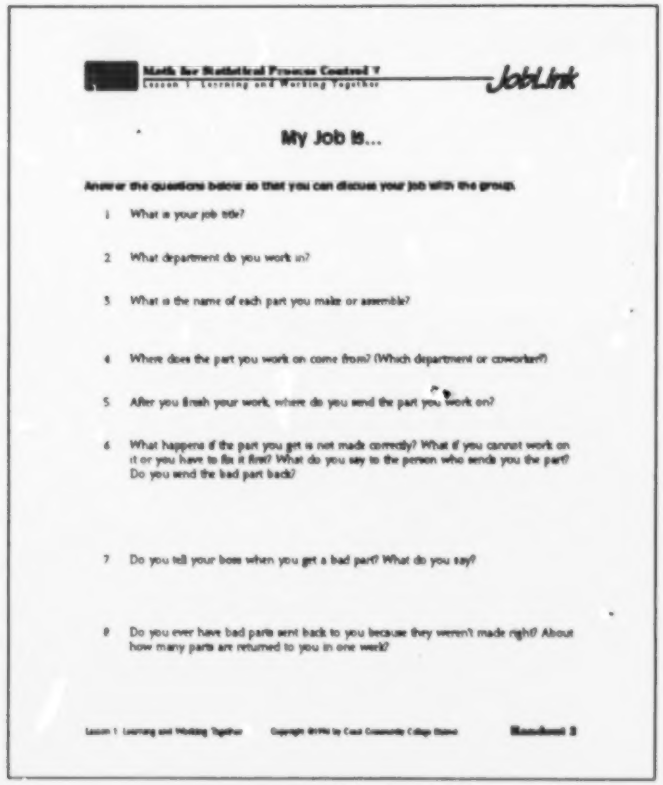

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Lesson 1: Learning and Working Together
JobLink

My Job Is...

Answer the questions below so that you can discuss your job with the group.

1. What is your job title?
2. What department do you work in?
3. What is the name of each part you make or assemble?
4. Where does the part you work on come from? (Which department or coworker?)
5. After you finish your work, where do you send the part you work on?
6. What happens if the part you get is not made correctly? What if you cannot work on it or you have to fix it first? What do you say to the person who sends you the part? Do you send the bad part back?
7. Do you tell your boss when you get a bad part? What do you say?
8. Do you ever have bad parts sent back to you because they weren't made right? About how many parts are returned to you in one week?

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Handout 2, Transparency 2

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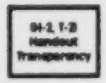
▼ Activities

▼ First Activity: 20 Minutes

1. **Regroup** the class into one large group again.

2. **Explain** to employees that this activity gives them an opportunity to express their opinions about what happens during the assembly process. **Tell** them the purpose is to help employees feel comfortable in describing to their coworkers (a) the jobs they do, (b) where the jobs come from, and (c) to whom they send the jobs after they complete their work.



3. **Distribute** "My Job Is..." and **project** it on the overhead. **Ask** for a volunteer to come to the front of the class to fill out his worksheet on the overhead with your help. **Tell** the other employees to follow your example as you guide the volunteer through each step of the worksheet. **Be** sensitive when you ask questions like "Do you say anything to the person that sent you a bad part?"

4. When they are finished, **call** on different employees to answer one or two questions. **Encourage** employees to verbalize what their jobs are all about and how their jobs fit into the "larger picture." *(Note: If the company makes furniture, you might hear something like this: "I work on desk tops. The desk I work on comes from the paint department. I install the wood-laminate top and send it to the hardware department, where they put on the handle knobs".)*

5. **Explain** to the class that if the product goes from station A to station B to station C, for example, then B is essentially A's customer and C is B's customer. The ultimate customer is the one who pays for the product! **Say,** "At every step of the process especially at the end the company's goal is a satisfied customer!"

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▼ Activities

▼ Second Activity: 20 Minutes

1. **Arrange** in advance for a guest speaker. **Invite** a key company representative *(for example, a vice president or a manager)* to address the group. **Explain** to the speaker that the presentation gives the company an opportunity:

    a. To stress the importance of teamwork and product quality.

    b. To convince employees that the company considers them its most valuable resource!

    c. To help employees understand (a) why their company makes the products it does, (b) why consumers value the product, and (c) how their individual jobs contribute to the final product.

    d. To offer employees a brief history of the company, its founders, its growth, its accomplishments, its goals, etc.

    (Note: If it is not possible to get a speaker, ask a company representative to write a special memo, and distribute it to the class at this time.)

2. **Distribute** brochures describing the companys product line, or **project** transparencies showing its products.

3. **Project** the organizational chart on the overhead. **Point out** key names (*President, CEO, Vice Presidents, etc.*); **include** interesting background information and accomplishments if possible, and *briefly* **discuss** their functions.

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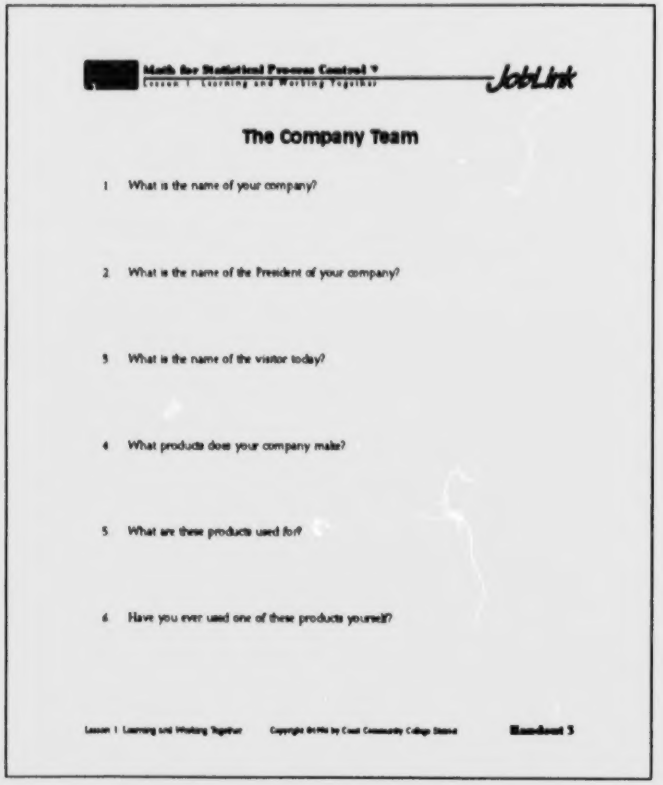
Math for Statistical Process Control ▼
Lesson 1: Learning and Working Together
JobLink
The Company Team
1. What is the name of your company?
2. What is the name of the President of your company?
3. What is the name of the visitor today?
4. What products does your company make?
5. What are these products used for?
6. Have you ever used one of these products yourself?
Lesson 1: Learning and Working Together
Handout 3

Handout 3, Transparency 3

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▼ Activities

▼ Second Activity: (continued)

4. **Mention** corporate awards *(e.g., from the Chamber of Commerce)*. **Read** corporate statements related to excellence or vision or dedication to customers.

5. Briefly **review** a recent corporate end-of-year report with the class. **Use** the opportunity to explain graphs and tables to the class.

6. **Distribute** "The Company Team" and **project** it on the overhead. **Allow** employees 5 minutes to complete it. *(Note: If you wish, skip the questions that are repeated from other worksheets.)*

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▼ *Activities*

▼ Third Activity: 15 Minutes

1. **Introduce** the concept of *Statistical Control Processes* (SPC) by showing one of the many videos about Edward Deming, the father of control theory. **Discuss** how Demings theories have helped industries first in Japan and now worldwide. **Use** any of the hundreds of books and articles on Deming to add to the class discussion.

2. **Ask** employees who are familiar with Quality Control to explain how their company applies SPC principles. **Ask** them to comment of how SPC contributes to product quality. Use the discussion to underscore the ideas that Quality Control (a) is an ongoing process and (b) is the responsibility of every employee. **Encourage** employees to **discuss** both ideas. **Invite** them to offer their own ideas for improving the quality control process.

3. **Show** some control charts *(see Lesson 6 for samples)*, but do not discuss them in detail. (If the company uses control charts, show real company examples.)

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▼ Activities

▼ Ending: 10 Minutes

1. **Ask** employees if they have any questions on what was presented in this session. **Ask,** too, if they would like more information on any particular part of the class discussion or on any related subject.

2. If the employees did not have enough time to complete the handouts, you may **ask** them to bring the completed handouts to the next class. Consider inviting the employees to bring to the next class any examples of their work related to SPC and using their examples for a show-and-tell.

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Lesson 2
Arithmetic Review

▼ Lesson Description

This lesson addresses several important goals. First, it quickly **reviews** basic arithmetic skills–the skills necessary to learn simple descriptive statistics and to calculate the mean and the standard deviation.

Depending on the class "mix," some employees may have mastered these skills while others are still learning. If so, then appeal to the employees' need for **cooperative learning,** a valuable goal in itself.

Group employees, carefully mixing the arithmetically weak with the strong. Help them to establish a rapport and a willingness to work together. Underscore that success in this company depends on workers, managers, and supervisors all working together to achieve a common goal: **improving individual and company well-being.**

In this lesson employees will also learn the skills necessary to use a calculator properly. And finally, employees will learn basic **problem-solving** skills.

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▼ Objectives

By completing this lesson, employees will be able to:

1. **Perform** addition, subtraction, multiplication, and division of whole numbers both with and without a calculator.
2. **Use** a calculator to take the square root of a number and interpret its meaning.
3. **Begin** developing problem-solving skills.

▼ Materials Needed

▼ Hardware

1. Overhead projector
2. Cusinaire rods
3. Overhead calculator
4. Employee calculators
5. Scratch paper

▼ Transparencies

"Reading & Writing Numbers" (Trans. 4)
"Your Turn" (Trans. 5)
"Addition of Whole Numbers" (Trans. 6)
"Substraction of Whole Numbers" (Trans. 7)
"Addition & Substraction of Word Problems" (Trans. 8)
"Mulitplication of Whole Numbers" (Trans 9)
"Division Problems" (Trans. 10)
"Division Word Problems" (Trans. 11)
"Square Roots" (Trans. 12)

▼ Materials Needed

▼ Handouts

"Reading & Writing Numbers" (Handout 4)
"Your Turn" (Handout 5)
"Addition of Whole Numbers" (Handout 6)
"Subtraction of Whole Numbers" (Handout 7)
"Addition & Subtraction of Word Problems" (Handout 8)
"Multiplication of Whole Numbers" (Handout 9)
"Division Problems" (Handout 10)
"Division Word Problems" (Handout 11)
"Square Roots" (Handout 12)

▼ Classroom Set-up

▼ Total Time: 90 minutes

Opening- Large Group	15 min.
First Activity- Large Group	20 min.
Second Activity- Large Group	15 min.
Third Activity- Large Group	10 min.
Fourth Activity- Large Group	25 min.
Ending- Large Group	5 min.

▼ Key — Hardware | Transparencies | Handouts | Large Group | Small Groups | Discussion | Sign-in Sheet

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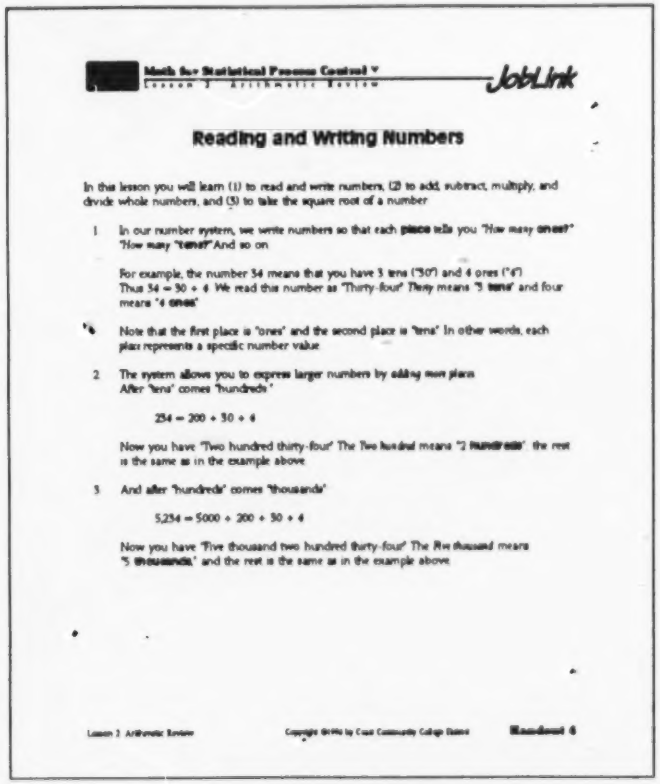

Math for Statistical Process Control ▼ JobLink
Lesson 2: Arithmetic Review

Reading and Writing Numbers

In this lesson you will learn (1) to read and write numbers, (2) to add, subtract, multiply, and divide whole numbers, and (3) to take the square root of a number.

1. In our number system, we write numbers so that each **place** tells you "How many **ones**?" "How many **tens**?" And so on.

   For example, the number 34 means that you have 3 tens ("30") and 4 ones ("4"). Thus 34 = 30 + 4. We read this number as "Thirty-four". *Thirty* means "3 **tens**" and *four* means "4 **ones**".

2. Note that the first place is "ones" and the second place is "tens". In other words, each place represents a specific number value.

3. The system allows you to express larger numbers by **adding more places**. After "tens" comes "hundreds."

   254 = 200 + 50 + 4

   Now you have "Two hundred thirty-four". The *Two hundred* means "2 **hundreds**", the rest is the same as in the example above.

4. And after "hundreds" comes "thousands".

   5,254 = 5000 + 200 + 50 + 4

   Now you have "Five thousand two hundred thirty-four". The *Five thousand* means "5 **thousands**," and the rest is the same as in the example above.

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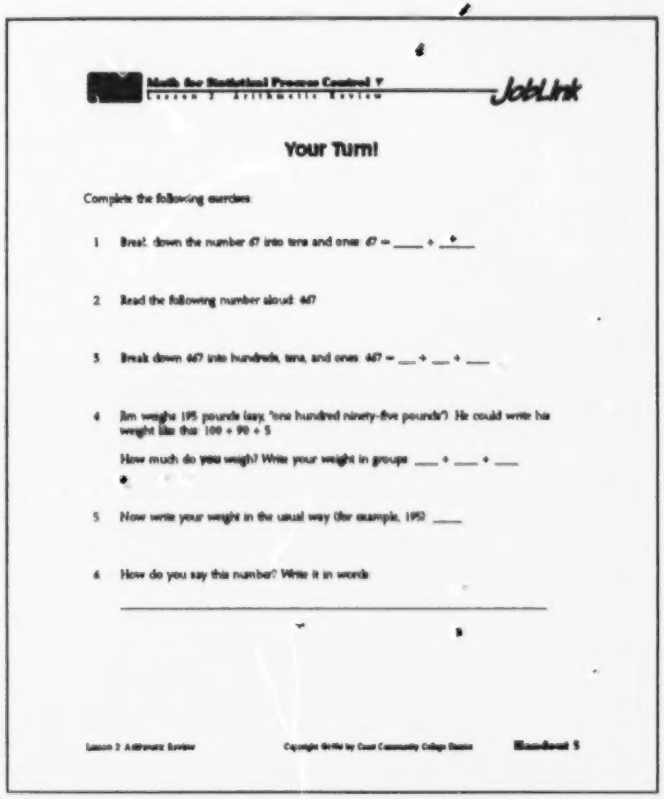
Handout 4, Transparency 4



Math for Statistical Process Control ▼ JobLink
Lesson 2: Arithmetic Review

Your Turn!

Complete the following exercises:

1. Break down the number 67 into tens and ones: 67 = ____ + ____

2. Read the following number aloud: 467

3. Break down 467 into hundreds, tens, and ones: 467 = ___ + ___ + ___

4. Jim weighs 195 pounds (say, "one hundred ninety-five pounds"). He could write his weight like this: 100 + 90 + 5

   How much do **you** weigh? Write your weight in groups: ___ + ___ + ___

5. Now write your weight in the usual way (for example, 195): ____

6. How do you say this number? Write it in words:

   _____

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Handout 5, Transparency 5

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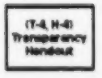
▼ Activities

▼ Opening: 15 Minutes

1. **Tell** the employees that this lesson is designed to review and strengthen their arithmetic skills. **Explain** that these skills are essential for understanding the concepts presented in this training program. **Stress** that these materials are designed to be easy to read and that you will try to simplify the concepts as much as possible. **Underscore** that the skills they will learn are critical for job success and exceptionally useful in personal life as well.



2. **Distribute** "Reading and Writing Numbers" and **project** it on the overhead. **Guide** employees through the explanation, **use** the examples to illustrate the concept of hundreds/tens/ones, and then **allow** employees a few minutes to complete the exercises.

3. **Distribute** "Your Turn".

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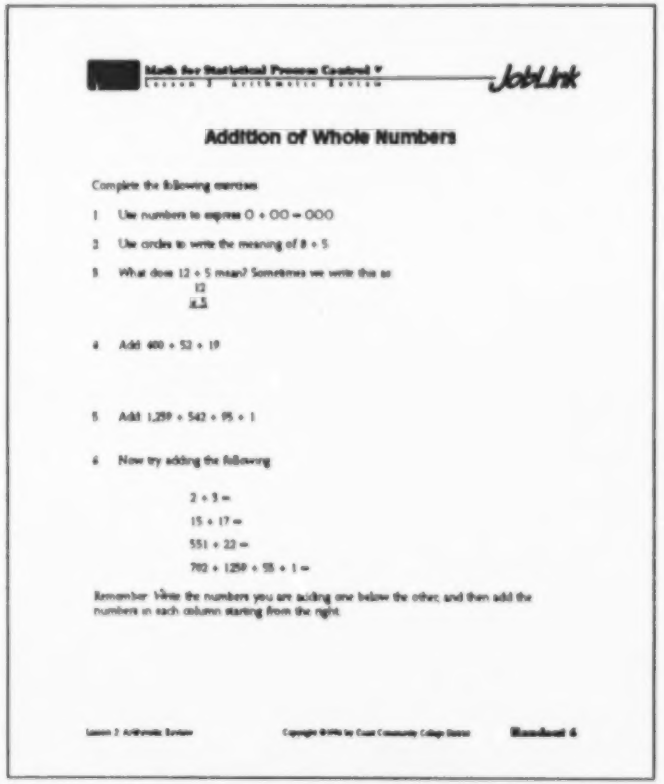
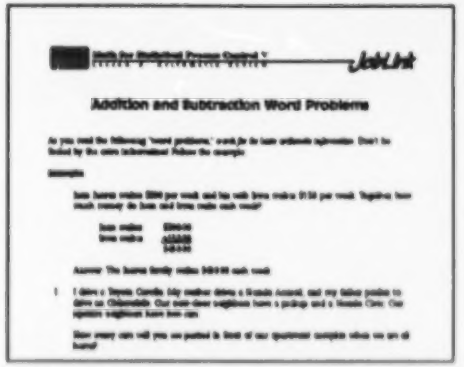
Handout 7, Transparency 7


Addition of Whole Numbers
Complete the following exercises
1 Use numbers to express O + OO = OOO
2 Use circles to write the meaning of 8 + 5
3 What does 12 + 5 mean? Sometimes we write this as
12
+5
4 Add 400 + 52 + 19
5 Add 1,259 + 542 + 95 + 1
6 Now try adding the following
2 + 3 =
15 + 17 =
551 + 22 =
702 + 1259 + 55 + 1 =
Remember: Write the numbers you are adding one below the other, and then add the numbers in each column starting from the right.

Handout 6, Transparency 6



Handout 8, Transparency 8

Handout 9, Transparency 9

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▼ Activities

▼ First Activity: 20 Minutes

1. **Simplify** for the class the concepts of *union of two sets* and *difference of two sets;* for example, **use** terms such as *putting together* and *taking away*. **Start** with the definition of addition. **Handout** and **project** "Addition of Whole Numbers".

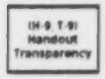
2. **Address** subtraction. **Distribute** and **project** "Subtraction of Whole Numbers". **Motivate** employees by using simple manipulatives *(the Cuisinaire rods)*, and involve the employees in the exercises whenever possible. **Start** with hand calculations; then gradually **switch over** to the calculator.

   set A = {all women in the class}, and set B = {all men in the class},
   set C = {all men and women in the class}, then
   # C = #A + #B (since A and B are disjoint sets) and is the total number of people in the room.

3. **Distribute** and **project** "Addition and Subtraction Word Problems". Have students complete worksheet, or complete as a class.

4. **Introduce** multiplication by placing the Cuisinaire dice, rods, and flats in rows and columns. For example, to illustrate the concept of 3 x 5, **arrange** the Cusinaire blocks (dice) in 3 rows of 5 sets, as follows:

   ○○○○○
   ○○○○○
   ○○○○○



5. **Distribute** and **project** "Multiplication of Whole Numbers".

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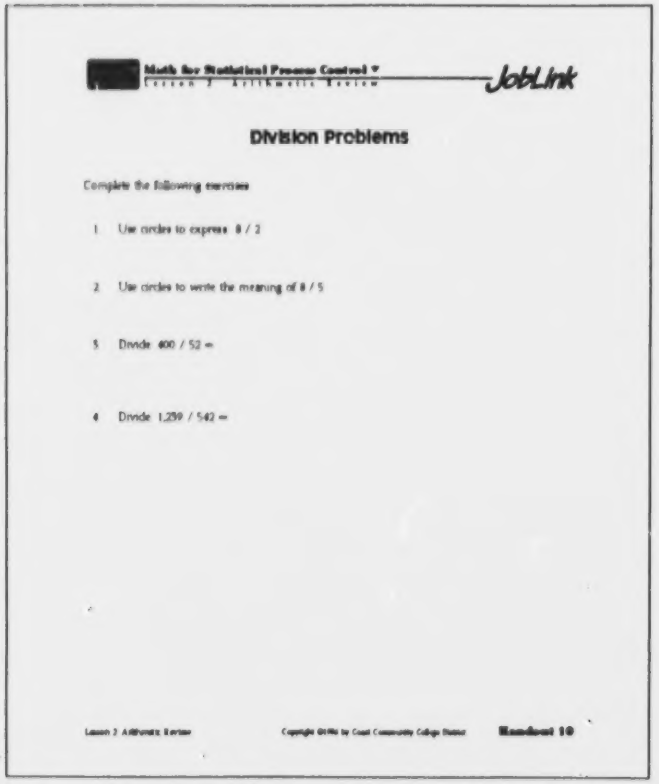

Math for Statistical Process Control ▼ — JobLink

Division Problems

Complete the following exercises

1. Use circles to express 8 / 2
2. Use circles to write the meaning of 8 / 5
3. Divide 400 / 52 =
4. Divide 1,259 / 542 =

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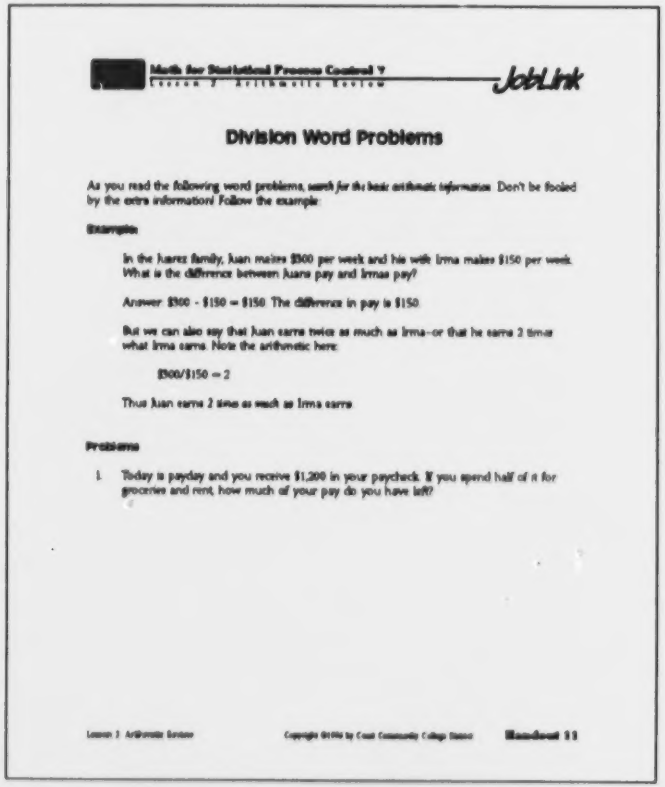
Handout 10, Transparency 10



Math for Statistical Process Control ▼ — JobLink

Division Word Problems

As you read the following word problems, search for the basic arithmetic information. Don't be fooled by the extra information! Follow the example:

Example

In the Juarez family, Juan makes $500 per week and his wife Irma makes $150 per week. What is the difference between Juans pay and Irmas pay?

Answer: $500 - $150 = $150. The difference in pay is $150.

But we can also say that Juan earns twice as much as Irma--or that he earns 2 times what Irma earns. Note the arithmetic here:

$500/$150 = 2

Thus Juan earns 2 times as much as Irma earns.

Problems

1. Today is payday and you receive $1,200 in your paycheck. If you spend half of it for groceries and rent, how much of your pay do you have left?

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Handout 11, Transparency 11

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▼ Activities

▼ Second Activity: 15 Minutes

1. For division, **reverse** the technique above. On the board, **write** 15 /5 = 3. Then **say,** "How can 15 be separated into 3 sets containing 5 blocks each?" **Reinforce** the concept by explaining that division is simply *repeated subtraction.*

2. **Dramatize** the concept by placing 12 plastic dice or coins on the overhead screen; **point out** to the class that there are 3 groups of 4 dice. On the board **write:**

   12 ÷ 4 = 3

3. Now **point out** that this equation says "Group this many objects-- OOOOOOOOOOOO -- into groups of four." In other words, group these objects as follows:

   OOOO / OOOO / OOOO

4. Next, **show** two numbers that do not divide "evenly," thus giving a decimal answer. For example:

   10 ÷ 4 = 10/4 = 2 2/4 = 2 1/2 = 2.5

   In other words, the answer 2.5 means "two and a half groups of fours," which we can represent as follows:

   OOOO / OOOO / OO

(H-10, T-10) Handout Transparency

(H-11, T-11) Handout Transparency

5. **Repeat** similar examples on the overhead screen. In the above example, **place** ten plastic dice end to end. **Take** a Cuisinaire that is four attached, a four-rod, and match it to the ten dice. It'll match 2 1/2 times. **Distribute** and **project** "Division Problems" and "Division Word Problems". Have students complete.

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▼ Activities

▼ Third Activity: 10 Minutes

1. **Tell** the employees that they will now have an opportunity to use the calculator. **Spend** a few minutes pointing out the keys. **Tell** them the number keys are arranged the same on all standard keypads (and telephones). Now **ask** them to find the *plus, minus, divide, multiply,* and *equals* keys, and **point out** and **explain** the Clear and the Clear Entry keys. *(If time allows, explain constant, memory, etc.)* **Save** for last the square root key, the purpose of this activity.

2. **Instruct** them to punch in 5 x 5. **Ask,** "Did everyone get 25? Thats the right answer." Illustrate the problem on the board as follows:

   $5 \times 5 = 25$

3. **Tell** them to immediately press the square root key. **Say,** "Did everyone now get 5? The square root of 25 is 5." Illustrate the problem on the board as follows:

   $\sqrt{25} = 5$

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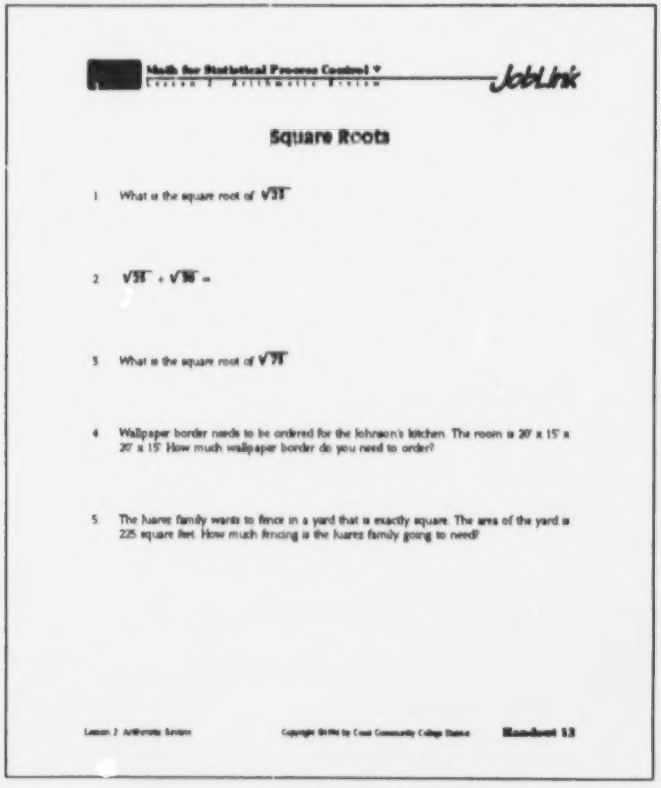
Math for Statistical Process Control ▼
Lesson 2: Arithmetic Review
JobLink
Square Roots
1. What is the square root of $\sqrt{81}$
2. $\sqrt{81} + \sqrt{36} =$
3. What is the square root of $\sqrt{75}$
4. Wallpaper border needs to be ordered for the Johnson's kitchen. The room is 20' x 15' x 20' x 15' How much wallpaper border do you need to order?
5. The Juarez family wants to fence in a yard that is exactly square. The area of the yard is 225 square feet. How much fencing is the Juarez family going to need?
Lesson 2: Arithmetic Review
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Handout 12

Handout 12, Transparency 12

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▼ Activities

▼ Third Activity: (continued)

4. **Say,** "You are probably wondering why and when you might use the square root key. Here's one example: Assume that you want to find *the side of a square* that has an area of 25 square yards for example, for carpeting. The square root key solves such problems for you *very* easily!" (Note: Of course, the underlying reason for teaching square roots is to prepare employees for the possibility of computing the *standard deviation of a distribution*. There is no need to explain that here.)

5. If time permits, **use** the calculator to solve hard square-root problems. For example, **ask** for the number of Cuisinare rods–dice–needed to make a square array of 20 dice. **Let** them struggle with it for a while, and then suggest that if fractional parts of a Cusinaire are allowed, then we would need a "little less than 4.5 dice" (since 4.5 x 4.5 = 20.25).

(H-12, T-12) Handout Transparency

6. **Distribute** and **project** "Square Roots".

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▼ Activities

▼ Fourth Activity: 25 Minutes

1. **Introduce** basic problem-solving. **Ask** employees to volunteer real-time problems and use their problems to establish a *process* for achieving solutions. In addition, **prepare** your own problems. For example:

   The packing department is allowed 20 hours of overtime each week. There are six workers in the department. One worker never wants to work overtime, but the other five are always willing to make a few extra dollars by working overtime. What is a fair share of overtime for each of these workers?

2. **Ask** the employees to answer the following questions:

   a. Can you restate the problem in your own words? (Do you understand the problem?)

   b. Can you draw a picture of the situation? (Any schematic will do–say, 5 or 6 stick figures for the workers and 20 boxes for the number of hours.)

   c. What is the question? (What are we looking for?)

   d. How do you plan to solve it? (State specifically: Subtract 1 from 6 and divide into 20)

   e. What is your solution, and does it make sense?

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▼ Activities

▼ Ending: 5 Minutes

1. **Summarize** key concepts.
2. **Ask** for questions.
3. Say **good-bye.**

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JobLink

Winning At Work

Math for Statistical Process Control

Making Numbers Count

Lesson 3
Decimals and Percents

▼ Lesson Description

Quality control engineers at companies involved in this project suggested adding this lesson to the PRE-SPC module. At their companies, employees routinely work with decimal amounts and compute percents, ratios, and proportions as part of their jobs. Your goal here is to learn how to measure the effectiveness of quality control in manufacturing processes. These math concepts are indispensable for this purpose.

But knowing these basics **pays off at home** too. All of us must understand credit card interest charges, bank fees, tax payments, payroll deductions, etc.

The first topic covered in this lesson is decimals, the core of our base ten number system. Understanding decimals is essential to expressing percents and rates.

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▼ Objectives

By completing this lesson, employees will be able to:

1. **Read** and **write** decimal numbers.
2. **Perform** the basic arithmetical operations using decimals.
3. **Solve** word problems involving decimals.
4. **Read** and **interpret** percent statements correctly.
5. **Calculate** percentages using a calculator.
6. **Read** and **interpret** ratio statements accurately.
7. **Compute** basic ratios to get "unit pricing"
8. **Solve** percent word problems.
9. **Express** work-related percent statements as meaningful operational objective.
10. **Understand** and **interpret** information expressed in the form of a rate.
11. **Calculate** rates with the aid of formulas and a calculator.
12. **Apply** their understanding of rates when they convert statistical data on the job, and represent the data on charts, models, etc.

▼ Materials Needed

▼ Hardware

1. Overhead projector and screen
2. Transparency pens
3. Cuisinaire blocks and dice (at least one set for every three employees)
4. Calculators
5. Transparent cuisinaire rods
6. Wire abacus

▼ Transparencies

"Decimal Numbers" (Transparency 13)

"Decimal Numbers: Adding and Subtracting" (Transparency 14)

"Decimal Numbers: Addition and Subtraction Word Problems" (Transparency 15)

"Decimal Numbers: Multiplying (Transparency 16)

"Using the Calculator" (Transparency 17)

"Decimal Numbers: Dividing" (Transparency 18)

"Percents" (Transparency 19)

"Rates" (Transparency 20)

▼ Materials Needed

▼ Handouts

"Decimal Numbers" (Handout 13)

"Decimal Numbers: Adding and Subtracting" (Handout 14)

"Decimal Numbers: Addition and Subtraction Word Problems" (Handout 15)

"Decimal Numbers: Multiplying (Handout 16)

"Using the Calculator" (Handout 17)

"Decimal Numbers: Dividing" (Handout 18)

"Percents" (Handout 19)

"Rates" (Handout 20)

▼ Classroom Set-up

▼ Total Time: 115 minutes

Opening- Large Group	10 min.
First Activity- Small Groups	15 min.
Second Activity- Large Group	15 min.
Third Activity- Large Group	15 min.
Fourth Activity- Large Group	30 min.
Fifty Activity- Large Group	25 min.
Ending- Large Group	5 min.

▼ Key — Hardware Transparencies Handouts Large Group Small Groups Discussion Sign-in Sheet

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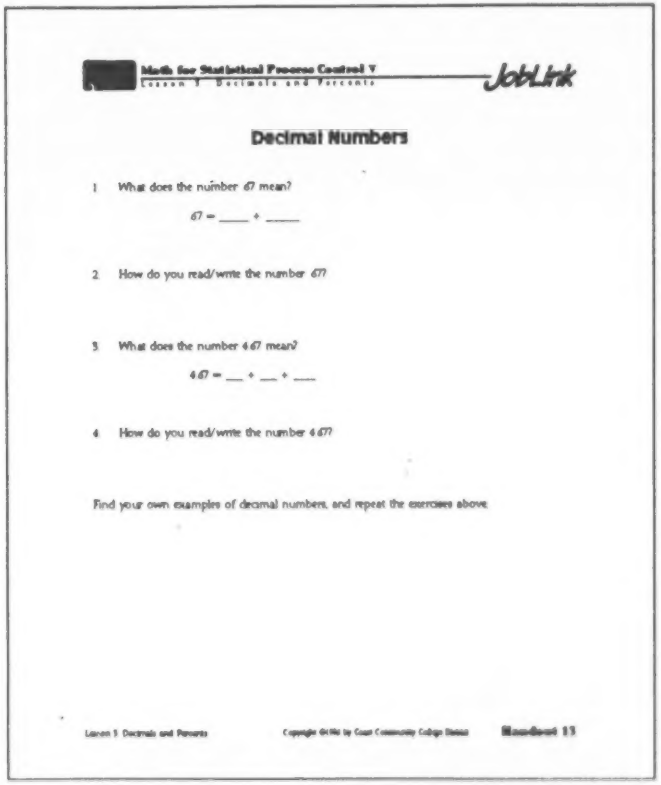

Math for Statistical Process Control ▼ JobLink
Lesson 3: Decimals and Percents

Decimal Numbers

1. What does the number .67 mean?

   .67 = ____ + ____

2. How do you read/write the number .67?

3. What does the number 4.67 mean?

   4.67 = ___ + ___ + ____

4. How do you read/write the number 4.67?

Find your own examples of decimal numbers, and repeat the exercises above.

Lesson 3: Decimals and Percents Copyright ©1996 by Coast Community College District Handout 13

Handout 13, Transparency 13

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▼ Activities

▼ Opening: 10 Minutes

1. **Say,** "In this lesson you will learn how to read and write numbers decimal numbers. You will also learn how to add, subtract, multiply, and divide decimal numbers."

2. To introduce decimals, **build on** the same procedure used in Lesson 2 for whole numbers. If an old-fashioned abacus is available, **use** it to demonstrate the meaning of *"place value"*; if not, on the board **write** the following (exaggerate the decimal point a bit) :

   ...hundreds tens ones . tenths hundredths thousandths...

3. **Remind** the class that numbers to the *left of the decimal* represent whole numbers–first ones, then tens, next hundreds, and so on. Stress that numbers to the right of the decimal represent *parts of* numbers–first tenths, then hundredths, next thousandths, and so on.

4. **Fill in** a number and use it to emphasize (a) the central position that the decimal point plays, (b) the "place value" to the *right* of the decimal point, and (c) the place value to the *left* of the decimal point. For example, **begin** with the number 1.34. **Explain** that it expresses 1 whole number, 3 tenths, and 4 hundredths. **Say** to the class, "Read this number as 'one and thirty-four hundredths.'"

5. **Distribute** "Decimal Numbers" and **project** it on the overhead. **Allow** the class time to complete the exercises.

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▼ Activities

▼ First Activity: 15 Minutes

1. **Use** the old-fashioned wire abacus (if available) to demonstrate addition and subtraction of decimals. **Underscore** that the procedure is the same as for whole numbers.

2. **Discuss** "carrying" in adding decimals and "borrowing" in subtracting decimals. **Stress** the similarity with adding and subtracting whole numbers. **Point out** that the decimal point is a separator–it divides the whole part of the number (the left side) from the fractional part, the decimal part, of the number (the right side).

3. **Involve** the employees in the discussion. **Ask** them specific questions to make sure that they grasp the basic principles.

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Decimal Numbers: Adding and Subtracting

1. What does 1.2 + 5 mean?

   1.2
   + 5

2. Add: 4.00 + 5.2 + .19

   4.00
   + 5.2
   + .19

3. Add: 12.59 + 54.2 + .95 + 10

4. What does 1.2 - 5 mean? How do you write this?

5. Subtract: 4.00 - 5.2

6. Subtract: 12.59 - 5.42

Handout 14, Transparency 14

Decimal Numbers:
Addition and Subtraction Word Problems

Complete the following exercises. Follow the example.

Example

Juan Juarez makes $225.50 per week and his wife Irma makes $150.75 per week. How much money do Irma and Juan earn each week?

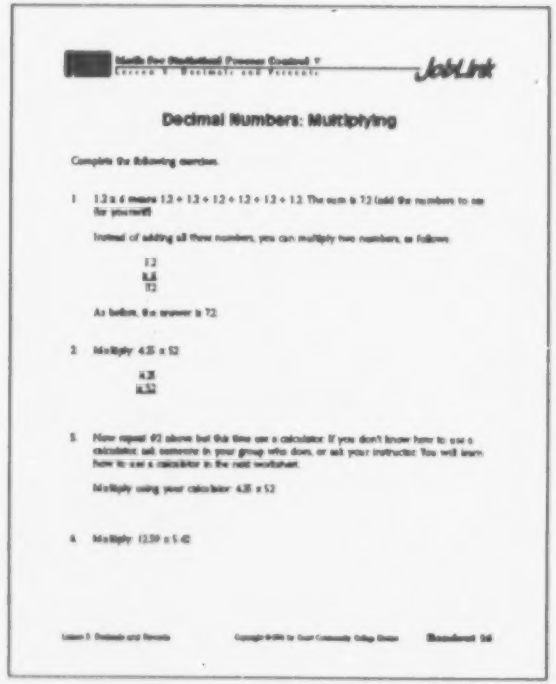
Juan makes = $225.50
Irma makes = $150.75
$376.25

Answer: Irma and Juan make $376.25 each week.

1. You have $1,508.50 in your checking account. Today is payday and you receive $1,245.50 in your paycheck. On your way home, you spend $188.57 for groceries. Then you decide to deposit the rest of your paycheck into your checking account.

   How much money do you have in your account after your deposit?

Handout 15, Transparency 15



Decimal Numbers: Multiplying

Complete the following exercises.

1. 1.2 x 6 means 1.2 + 1.2 + 1.2 + 1.2 + 1.2 + 1.2. The sum is 7.2 (add the numbers to see for yourself).

   Instead of adding all these numbers, you can multiply two numbers, as follows:

   1.2
   x 6
   7.2

   As before, the answer is 7.2.

2. Multiply: 4.25 x 12

   4.25
   x 12

3. Now repeat #2 above but this time use a calculator. If you don't know how to use a calculator, ask someone in your group who does, or ask your instructor. You will learn how to use a calculator in the next worksheet.

   Multiply using your calculator: 4.25 x 12

4. Multiply: 12.59 x 5.42

Handout 16, Transparency 16

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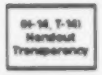
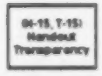
▼ Activities

▼ First Activity: (continued)

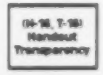
4. **Dramatize** the need to count the number of positions in the original two numbers. **Explain** why we count by (a) using a common fraction such as a/b, (b) using the geometric definition of multiplication, or (c) placing the numbers in expanded notation and using the distributive law. **Take** the practical approach and simply state the rule. *(Note: If anyone wants a full explanation, ask her or him to meet you after class.)*



5. **Distribute** "Decimal Numbers: Adding and Subtracting", and **project** it on the overhead. **Walk around** the room to help employees with any problems they may have.



6. **Distribute** "Decimal Numbers: Addition and Subtraction Word Problems". **Discuss** each problem to make sure that employees understand them; then allow them time to complete these exercises.



7. **Demonstrate** how we multiply two decimals. **Stress** that the process is precisely the same as multiplying whole numbers; the "trick" lies in positioning the decimal point in the answer! **Distribute** "Decimal Numbers: Multiplying" and **project** it on the overhead.

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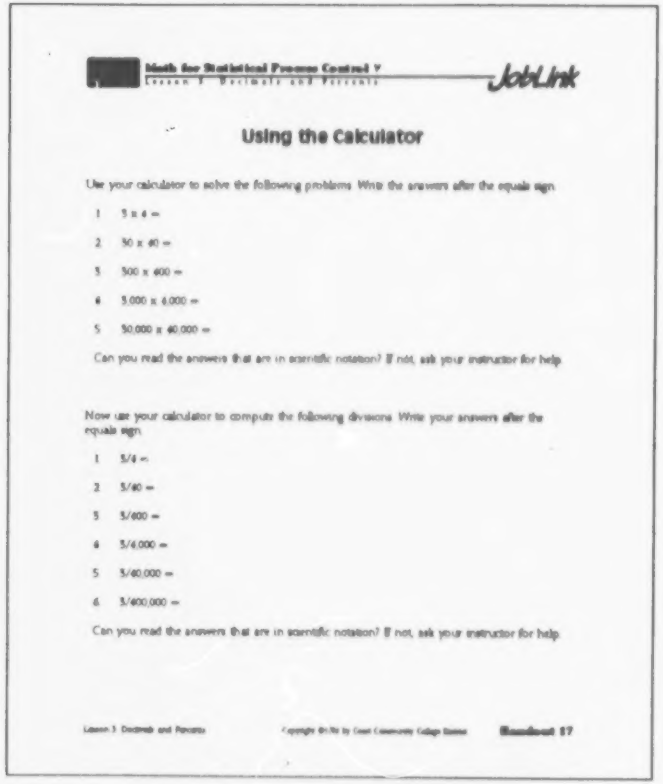

Math for Statistical Process Control ▼ JobLink
Lesson 3: Decimals and Percents

Using the Calculator

Use your calculator to solve the following problems. Write the answers after the equals sign.

1. 5 x 4 =
2. 50 x 40 =
3. 500 x 400 =
4. 5,000 x 4,000 =
5. 50,000 x 40,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

Now use your calculator to compute the following divisions. Write your answers after the equals sign.

1. 5/4 =
2. 5/40 =
3. 5/400 =
4. 5/4,000 =
5. 5/40,000 =
6. 5/400,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

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Handout 17, Transparency 17

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▼ Activities

▼ Second Activity: 15 Minutes

Instructor: Address decimal division later, after this lesson on calculators, so that employees will learn how to use the calculator for problem-solving.

1. **Say,** "We all know how convenient calculators are. They facilitate calculations and save a lot of time!" Now **tell** employees that in this lesson they will use the calculator to learn the rudiments of scientific notation. **Explain** that in calculations, especially decimal calculations, they might encounter this type of readout.

2. **Explain** the concept of *scientific notation* (at least as far as it applies to the calculator). Use an overhead calculator if available *(if not, use the board or the overhead).* **Be sure** to mention *exponents.*

   Scientific Notation: a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. For example: Scientific notation of 10,492 is 1.0492 x 10^4 (American Heritage Dictionary)
   Exponents: A number or symbol placed to the right of and above another number, symbol, or expression denoting the power to which that number, symbol, or expression is to be raised.

(M-17, T-17) Handout Transparency

3. **Distribute** and **project** "Using the Calculator". **Use** the first exercise to teach employees to multiply with a calculator and to deal with scientific notation. **Emphasize** that (3000 x 4000) should read as 1.2 E 6 on most nonscientific calculators. (If it does not on your calculators, **add** more zeros to the numbers.) **Explain** this scientific notation carefully. Do the same for the division problems, which may be trickier.

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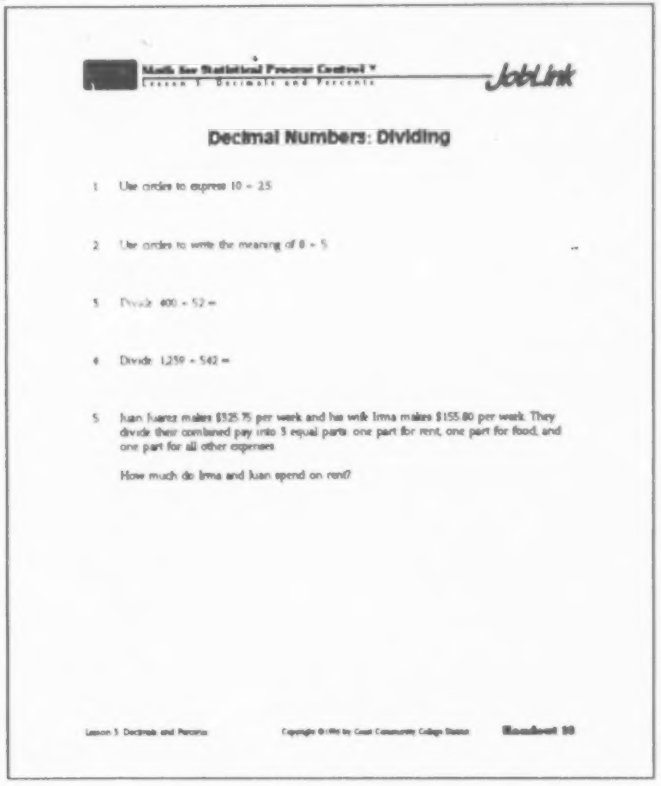

Math for Statistical Process Control ▼ JobLink
Lesson 3: Decimals and Percents

Decimal Numbers: Dividing

1. Use circles to express 10 ÷ 2.5

2. Use circles to write the meaning of 8 ÷ 5

3. Divide 400 ÷ 52 =

4. Divide 1,259 ÷ 542 =

5. Juan Juarez makes $525.75 per week and his wife Irma makes $155.80 per week. They divide their combined pay into 3 equal parts: one part for rent, one part for food, and one part for all other expenses.

   How much do Irma and Juan spend on rent?

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Handout 18, Transparency 18

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▼ Activities

▼ Third Activity: 15 Minutes

1. **Remind** employees that division is simply *repeated* subtraction. Now **tell** them they will divide decimals, and admit to them that decimal division is trickier.

2. On the overhead screen **place** 15 plastic cubes *(or even better, paper units that you can easily cut)* and **ask** the class to divide the 15 into two equal groups–that is, to perform the division 15 ÷ 2. (Answer: 7 and one half, or 7 .5, in each group.)

3. **Distribute** and **project** "Decimal Numbers: Dividing".

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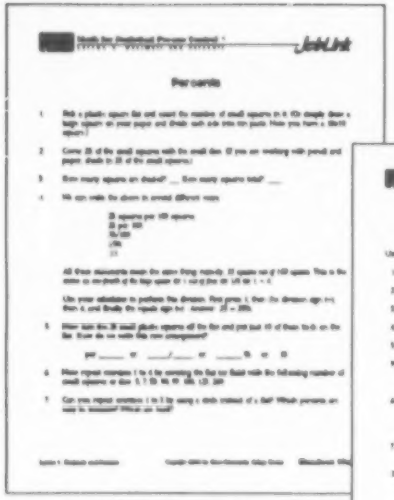
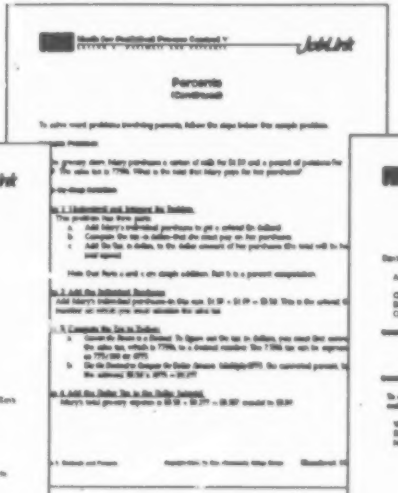


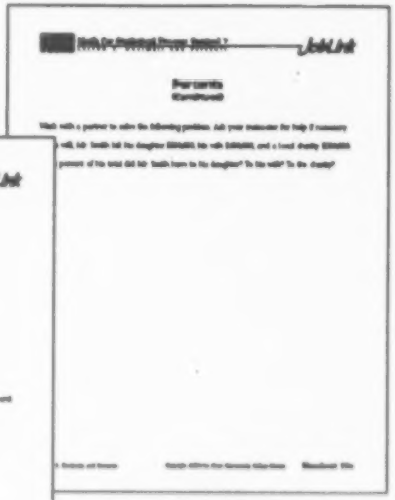
Handout 19a,
Transparency 19a

Handout 19b,
Transparency 19b



Handout 19c,
Transparency 19c

Handout 19d,
Transparency 19d



Handout 19e,
Transparency 19e

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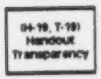
▼ Activities

▼ Fourth Activity: 30 Minutes

1. **Review** percents with the class. Include examples of how they use percents everyday as they compute interest rates, sales tax, discounts, price increases, savings, etc.

2. **Project** the plastic sheets of Cusinaire dice, rods, and flats (and to a lesser extent, the cubes) to introduce the idea of percent. **(Use** simple hand-drawn squares if the transparencies are not available.) **Group** the class into teams of two. **Distribute** the "plastic rods" (a term simpler than Cusinaire rods).



3. **Distribute** and **project** "Percents" and complete the exercises. Repeat the exercises many times with different numbers. **Experiment** with the employees by asking them to cover a (10x10) flat with 90 small dice, 100, 120...(120%).

4. **Write** 25% = .25 on the board, and **explain** why the percent and the decimal are indeed equivalents. **Allow** employees to use the calculator as you write on the board
$25\% = 1/4 = 1 \div 4 = .25$.

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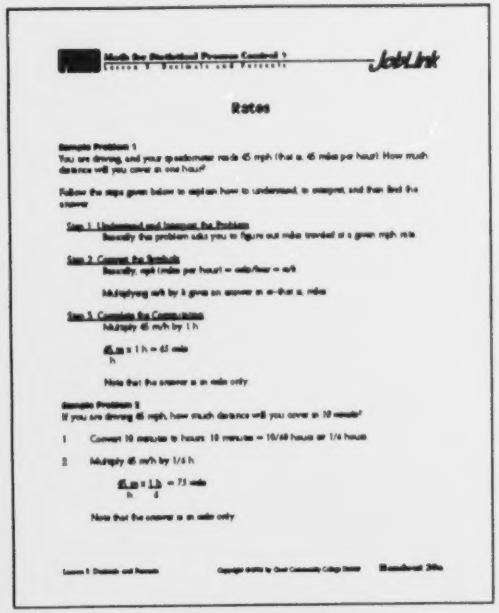


Rates

Example Problem 1
You are driving, and your speedometer reads 45 mph (that is, 45 miles per hour). How much distance will you cover in one hour?

Follow the steps given below to explain how to understand, to interpret, and then find the answer.

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out miles traveled at a given mph rate.

Step 2: Convert the Symbols
Basically, mph (miles per hour) = miles/hour = m/h

Multiplying m/h by h gives an answer in m-that is, miles.

Step 3: Complete the Computations
Multiply 45 m/h by 1 h

$\frac{45\ m}{h} \times 1\ h = 45$ miles

Note that the answer is in miles only.

Example Problem 2
If you are driving 45 mph, how much distance will you cover in 10 minutes?

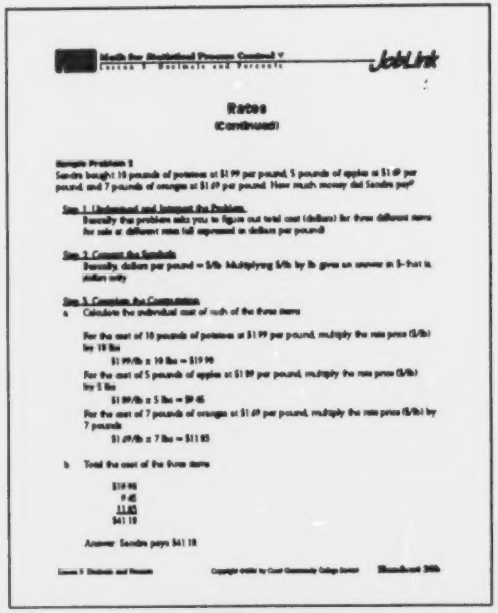
1. Convert 10 minutes to hours: 10 minutes = 10/60 hours or 1/6 hours
2. Multiply 45 m/h by 1/6 h

$\frac{45\ m}{h} \times \frac{1\ h}{6} = 7.5$ miles

Note that the answer is in miles only.

Lesson 3: Decimals and Percents — Copyright ©1996 by Coast Community College District — Handout 20a

Handout 20a, Transparency 20a



Rates
(Continued)

Example Problem 3
Sandra bought 10 pounds of potatoes at $1.99 per pound, 5 pounds of apples at $1.49 per pound, and 7 pounds of oranges at $1.69 per pound. How much money did Sandra pay?

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out total cost (dollars) for three different items for sale at different rates (all expressed in dollars per pound).

Step 2: Convert the Symbols
Basically, dollars per pound = $/lb. Multiplying $/lb by lb gives an answer in $-that is, dollars only.

Step 3: Complete the Computations
a. Calculate the individual cost of each of the three items.

For the cost of 10 pounds of potatoes at $1.99 per pound, multiply the rate price ($/lb) by 10 lbs:
$1.99/lb x 10 lbs = $19.90

For the cost of 5 pounds of apples at $1.89 per pound, multiply the rate price ($/lb) by 5 lbs:
$1.89/lb x 5 lbs = $9.45

For the cost of 7 pounds of oranges at $1.69 per pound, multiply the rate price ($/lb) by 7 pounds:
$1.69/lb x 7 lbs = $11.83

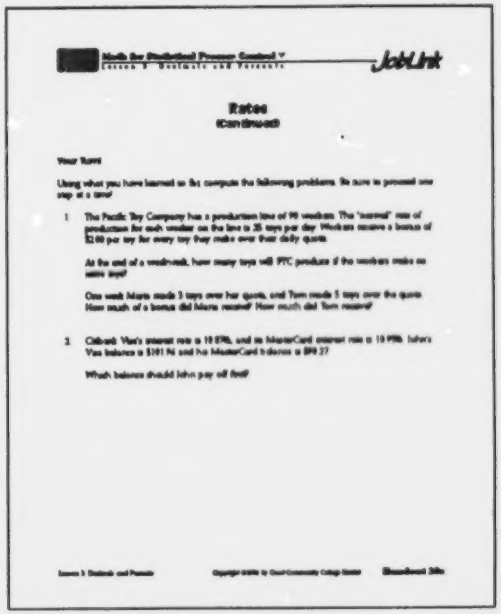
b. Total the cost of the three items:

$19.90
9.45
11.83
$41.18

Answer: Sandra pays $41.18

Lesson 3: Decimals and Percents — Copyright ©1996 by Coast Community College District — Handout 20b

Handout 20b, Transparency 20b



Rates
(Continued)

Your Turn

Using what you have learned so far, complete the following problems. Be sure to proceed one step at a time!

1. The Pacific Toy Company has a production line of 90 workers. The "normal" rate of production for each worker on the line is 35 toys per day. Workers receive a bonus of $2.00 per toy for every toy they make over their daily quota.

   At the end of a weekend, how many toys will PTC produce if the workers make no extra toys?

   One week Maria made 3 toys over her quota, and Tom made 5 toys over the quota. How much of a bonus did Maria receive? How much did Tom receive?

2. Citibank: Visa's interest rate is 19.8%, and its MasterCard interest rate is 19.9%. John's Visa balance is $301.96 and his MasterCard balance is $99.27.

   Which balance should John pay off first?

Lesson 3: Decimals and Percents — Copyright ©1996 by Coast Community College District — Handout 20c

Handout 20c, Transparency 20c

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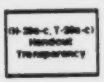
▼ Activities

▼ Fifth Activity: 25 Minutes

1. **Introduce** the concept of rate. **Say,** "You use rates every day. For example, *55 mph, $1.47 per gallon, $1.34 per ounce, $1.99 per pound*–all are examples of rates."

2. **Explain** that *percent* is also a rate–for instance, *an interest rate of 12%.*

3. **Discuss** rates such as the ones mentioned above and other simple, familiar rates; **proceed** to proportions if the class easily grasps the concept of rate.



4. **Distribute** and **project** "Rates".

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▼ Activities

▼ Ending: 5 Minutes

1. **Summarize** the concepts taught today.
   - Decimals
   - Percents
   - Rates

2. **Tell** the students good-bye.

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Lesson 4
Descriptive Statistics

▼ Lesson Description

The ability to read and interpret descriptive statistical graphs (tables, graphs, and charts) and draw conclusions from them is an essential skill for productive employees and intelligent citizens. In industry, perhaps as much as 90% of the statistics used are descriptive statistics.

Daily newspapers and magazines routinely communicate information by using tables, graphs, and charts because graphs present a lot of information quickly and succinctly. Likewise, companies routinely use descriptive statistics to communicate important information to their employees. Productive, promotable employees need to understand descriptive statistics as well as they understand oral and written communications.

In this lesson employees build skill in two ways: by learning to **read** graphs and learning to **build** them. This lesson is closely linked to the last lesson, on control charts.

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▼ Objectives

By completing this lesson, employees will be able to:

1. **Read,** interpret, and build frequency tables.
2. **Read,** interpret, and build bar graphs.
3. **Read,** interpret, and build line graphs.
4. **Read** and interpret circle graphs.
5. **Explain** how descriptive statistics relate to quality control.

▼ Materials Needed

▼ Hardware

1. Overhead projector and screen
2. Transparency pens
3. Cuisinaire rods
4. Plastic or cardboard circle graphs (like pizza slices)
5. Calculators (one per employee)
6. Large scissors
7. Construction paper

▼ Materials (cont'd)

▼ Transparencies

"Rainfall for the week of 3/9" (Trans. 21)
"Temperature on March 9" (Trans. 22)
"Costs for XYZ, Inc" (Trans. 23)
"Reading Graphs and Tables" (Trans. 24)
"Reading and Interpreting Tables" (Trans. 25)
"Reading and Interpreting Bar Graphs" (Trans. 26)
"Reading and Interpreting Line Graphs" (Trans. 27a & 27b)
"Comparing Line Graphs" (Trans. 28)
"Reading & Interpreting Circle Graphs" (Trans. 29)
"Building Frequency Tables" (Trans. 30)
"Building Bar Charts" (Trans. 31)

▼ Handouts

"Rainfall for the week of 3/9" (Handout 21)
"Temperature on March 9" (Handout 22)
"Costs for XYZ, Inc" (Handout 23)
"Reading Graphs and Tables" (Handout 24)
"Reading and Interpreting Tables" (Handout 25)
"Reading and Interpreting Bar Graphs" (Handout 26)

▼ Materials (cont'd)

"Reading and Interpreting Line Graphs" (Handout 27a & 27b)
"Comparing Line Graphs" (Handout 28)
"Reading and Interpreting Circle Graphs" (Handout 29)
"Building Frequency Tables" (Handout 30)
"Building Bar Charts" (Handout 31)

▼ Classroom Set-up

▼ Total Time: 90 minutes

Opening- Large Group	10 min.
First Activity- Large Group	20 min.
Second Activity- Small Groups	30 min.
Third Activity- Large Group	15 min.
Ending- Large Group	15 min.

▼ Key — Hardware | Transparencies | Handouts | Large Group | Small Groups | Discussion | Sign-in Sheet

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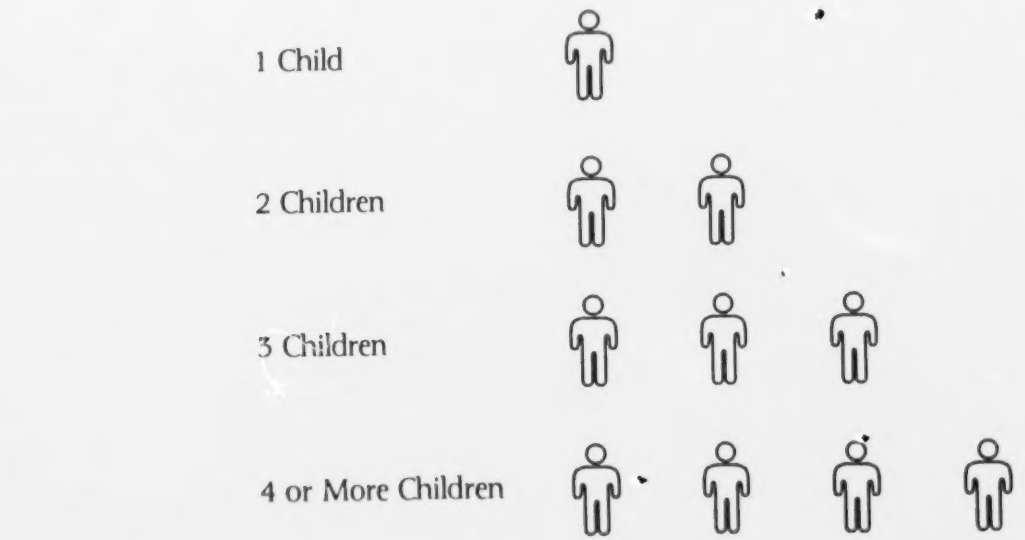
▼ Activities

▼ Opening: 10 Minutes

1. **Welcome** employees. **Tell** them that the opening activity will be fun, and **explain** that they will learn the basics of bar graphs. **Try** to ease employees' anxiety about this lesson.

2. **Draw** employees a bar graph such as this one:



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▼ Activities

▼ Opening: (continued)

3. **Explain** that the class will now form a "human bar graph." **Proceed** as follows:

   Ask employees to line up on one side of the room. **Stand** in front of them and then **say,** "How many of you have children?"

   Now **ask** those who have no children (that is, those who did not raise their hands) to form a single file behind you.

   Repeat this process with the "children group." **Ask,** "How many of you have only one child?"

   Then **ask,** "How many of you have two children?"

   Continue in this way, forming a simple "human bar graph."

   When finished, **discuss** the meaning of the "graph" with the class.

4. **Repeat** the exercise with other criteria, such as:

   Number of years with this company

   Number of years working

   Number of years in the United States

   By city where they reside (this is a pictograph)

   By country of origin

   By music preference (Classical, Country, Pop, Jazz)

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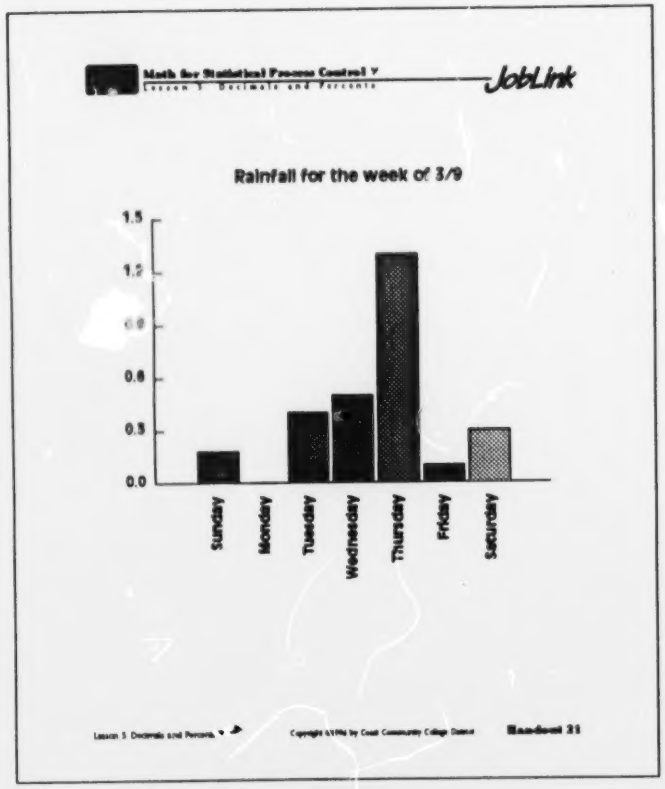
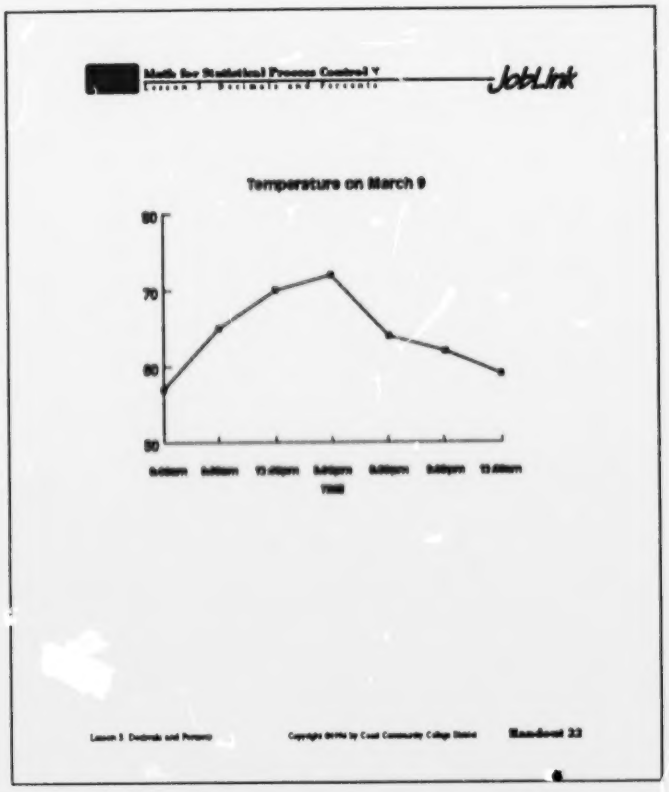


Handout 21, Transparency 21



Handout 22, Transparency 22

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Activities

First Activity: 20 Minutes

1. **Distribute** and **project** "Rainfall for the week of 3/9".

(H-21, T-21) Handout Transparency

NOTE: If you have actual charts from the company they should be used instead of the generic charts provided.

2. **Explain** that this type of graph is called a bar graph. **Explain** how to read the graph. **Say,** "According to this graph the week of 3/9 we got .2 inches of rain on Sunday.

3. **Ask** the class,

   How much rain did we get on Wednesday?
   Which day did we get the most rain?
   Which day did we get the least amount of rain.

(H-22, T-22) Handout Transparency

4. **Distribute** and **project** "Temperature on March 9.

5. **Explain** that this type of graph is called a line graph. **Explain** how to read.

6. **Say,** "According to this graph at 6:00 am the temperature was 56 degrees.

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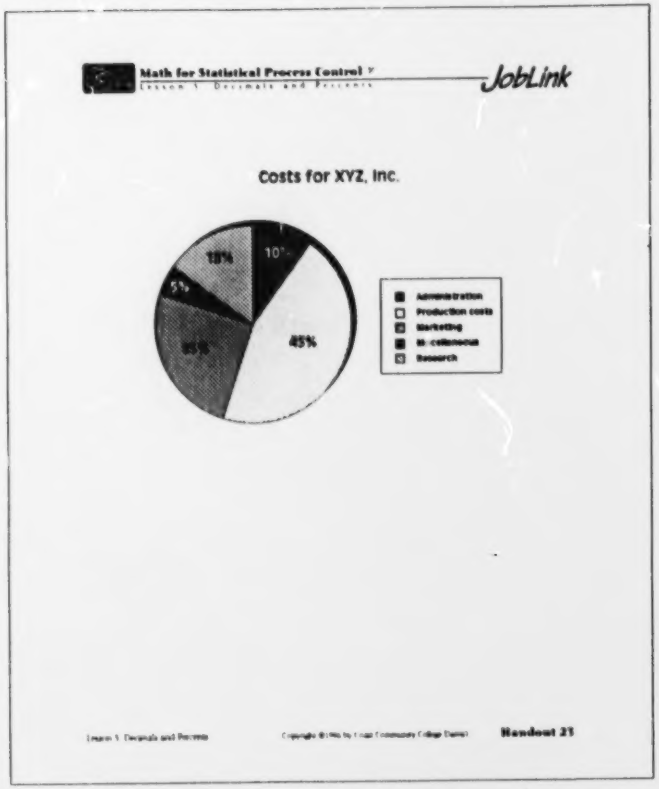
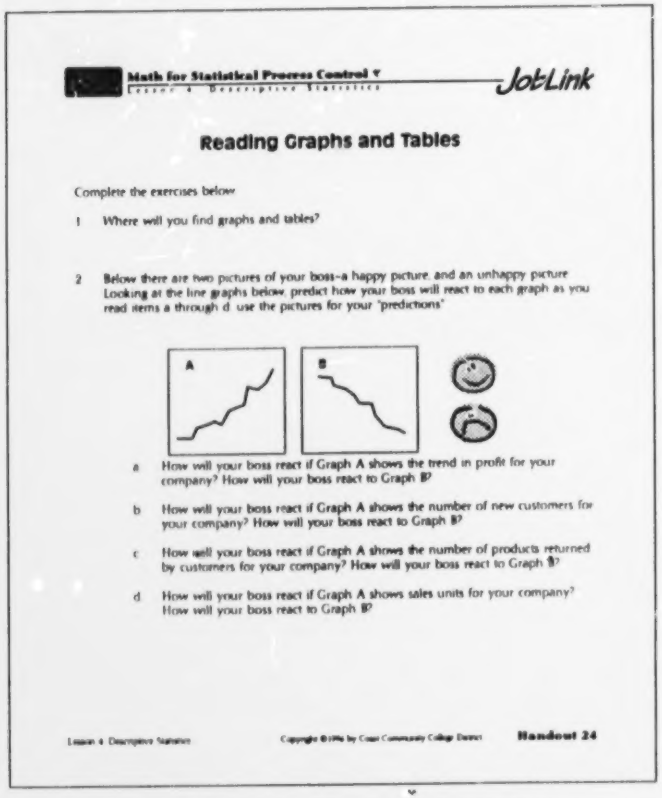


Handout 23, Transparency 23


Math for Statistical Process Control ▼
JobLink
Reading Graphs and Tables
Complete the exercises below.
1 Where will you find graphs and tables?
2 Below there are two pictures of your boss–a happy picture and an unhappy picture. Looking at the line graphs below, predict how your boss will react to each graph as you read items a through d. use the pictures for your "predictions"
A
B
a How will your boss react if Graph A shows the trend in profit for your company? How will your boss react to Graph B?
b How will your boss react if Graph A shows the number of new customers for your company? How will your boss react to Graph B?
c How will your boss react if Graph A shows the number of products returned by customers for your company? How will your boss react to Graph B?
d How will your boss react if Graph A shows sales units for your company? How will your boss react to Graph B?
Handout 24

Handout 24, Transparency 24

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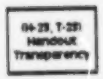
▼ Activities

▼ First Activity: (continued)

7. **Ask** the following questions,

   What was the temperature at 9:00 am?
   What was the temperature at 9:00 pm?
   What was the highest temperature of the day? At what time?
   What was the lowest temperature of the day? At what time?



8. **Distribute** and **project** "Costs for XYZ, Inc".

9. **Explain** that this is called a pie chart. **Explain** how to read the chart.

10. **Say,** "According to this graph, 15% of XYZ's expenses went to research.

11. **Ask,**

    How much of the costs went to Administration?
    How much of the costs went to Marketing?
    Where do most of the costs go?

12. **Distribute** and **project** "Reading Graphs and Tables".

13. Have students answer the questions on the handout. **Walk around** the room and help them answer the questions.

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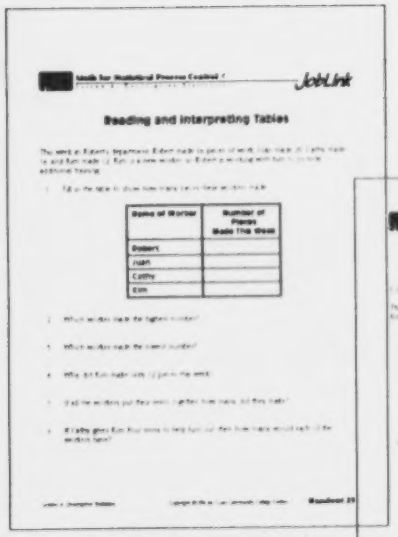
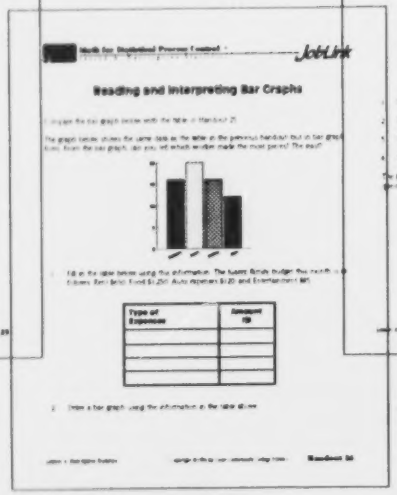
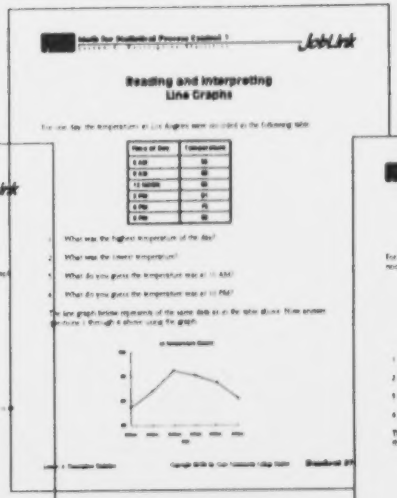


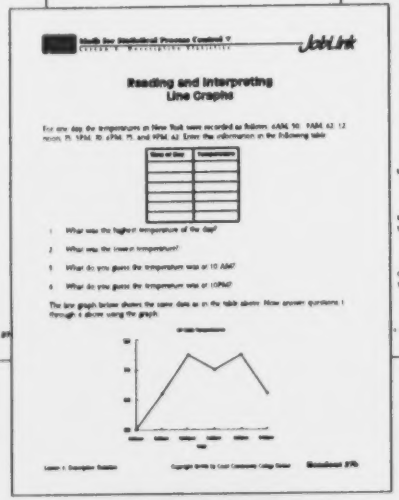
Handout 25,
Transparency 25



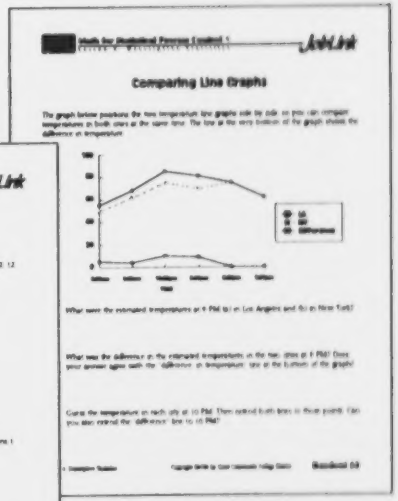
Handout 26,
Transparency 26



Handout 27a
Transparency 27a



Handout 27b,
Transparency 27b



Handout 28
Transparency 28

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▼ Activities

▼ Second Activity: 30 Minutes

Note to Instructor: Let the employees do as much of the work as possible in this activity.

1. **Tell** employees that in this activity they will begin to build simple frequency tables, bar graphs, and line graphs.

2. **Distribute** and **project**—

"Reading and Interpreting Tables"
"Reading and Interpreting Bar Graphs"
"Reading and Interpreting Line Graphs"
"Comparing Line Graphs"

3. **Explain** that they will start with simple bar graphs and line graphs. Then they will work on more frequency tables and bar graphs. Circle graphs will be read and will be done last.

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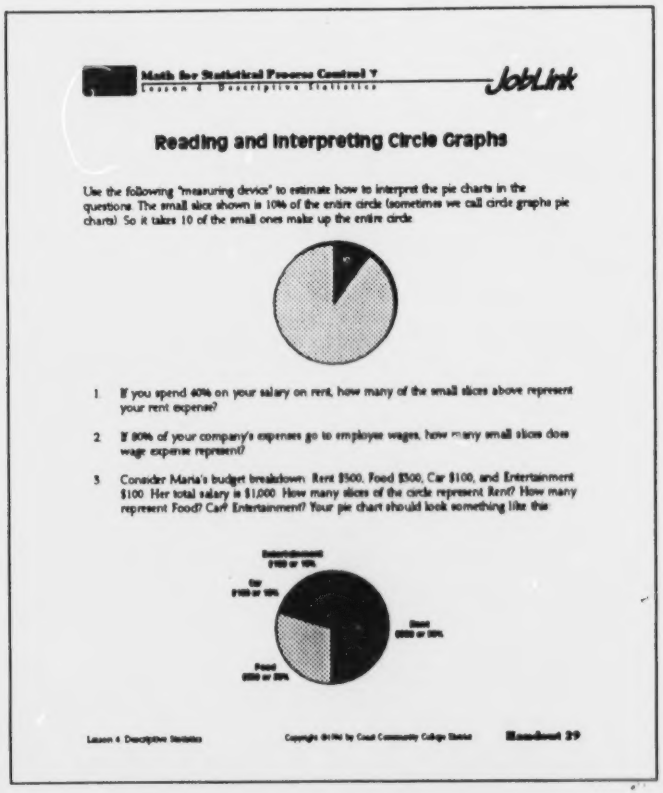
Math for Statistical Process Control ▼
Lesson 4: Descriptive Statistics
JobLink
Reading and Interpreting Circle Graphs
Use the following "measuring device" to estimate how to interpret the pie charts in the questions. The small slice shown is 10% of the entire circle (sometimes we call circle graphs pie charts). So it takes 10 of the small ones make up the entire circle.
1. If you spend 40% on your salary on rent, how many of the small slices above represent your rent expense?
2. If 80% of your company's expenses go to employee wages, how many small slices does wage expense represent?
3. Consider Maria's budget breakdown. Rent $500, Food $300, Car $100, and Entertainment $100. Her total salary is $1,000. How many slices of the circle represent Rent? How many represent Food? Car? Entertainment? Your pie chart should look something like this.
Lesson 4: Descriptive Statistics
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Handout 29

Handout 29, Transparency 29

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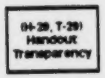
▼ Activities

▼ Third Activity: 15 Minutes

1. **Use** the "pizza slices" to introduce employees *circle graphs* and *pie charts*. **Start** with a slice of 10% (36°) as a measuring device.

2. To show employees how to estimate using manipulatives. If you want to be more specific, cut out an entire circle from construction paper, and **cut out** additional slices of about 36° (10% of the circle) and 90° (25% of the circle).



3. **Distribute** and **project** "Reading and Interpreting Circle Graphs".

4. Have students complete.

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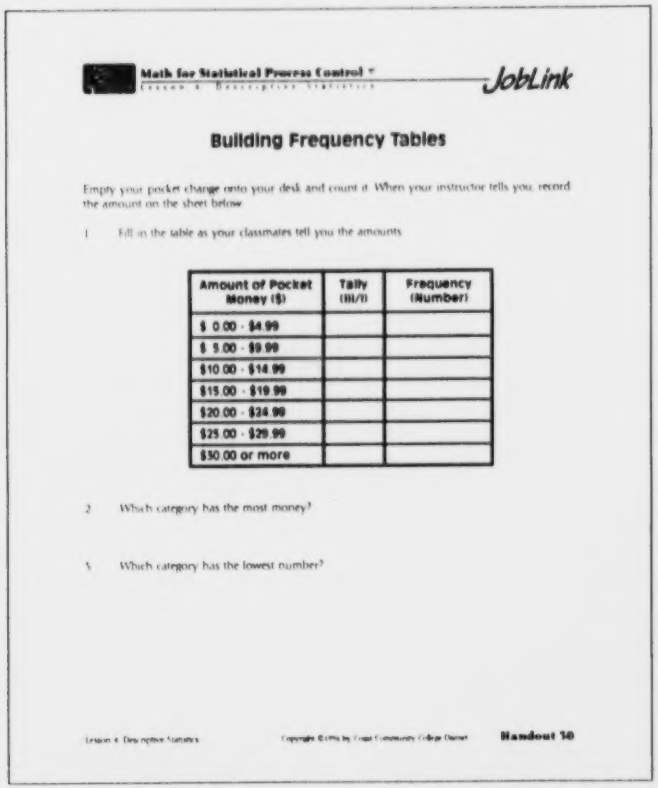


Math for Statistical Process Control ▼ JobLink

Building Frequency Tables

Empty your pocket change onto your desk and count it. When your instructor tells you, record the amount on the sheet below.

1. Fill in the table as your classmates tell you the amounts.

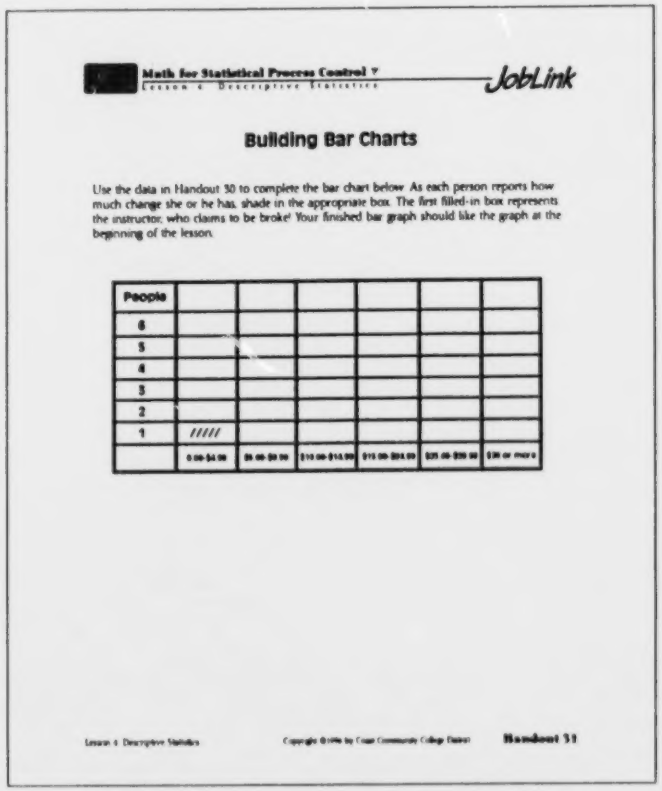
Amount of Pocket Money ($)	Tally (III/I)	Frequency (Number)
$ 0.00 - $4.99		
$ 5.00 - $9.99		
$10.00 - $14.99		
$15.00 - $19.99		
$20.00 - $24.99		
$25.00 - $29.99		
$30.00 or more		

2. Which category has the most money?

3. Which category has the lowest number?

Lesson 4: Descriptive Statistics Copyright ©1996 by Coast Community College District **Handout 30**

Handout 30, Transparency 30



Math for Statistical Process Control ▼ JobLink

Building Bar Charts

Use the data in Handout 30 to complete the bar chart below. As each person reports how much change she or he has, shade in the appropriate box. The first filled-in box represents the instructor, who claims to be broke! Your finished bar graph should like the graph at the beginning of the lesson.

People							
6							
5							
4							
3							
2							
1	/////						
	$0.00-$4.99	$5.00-$9.99	$10.00-$14.99	$15.00-$19.99	$20.00-$24.99	$25.00-$29.99	$30 or more

Lesson 4: Descriptive Statistics Copyright ©1996 by Coast Community College District **Handout 31**

Handout 31, Transparency 31

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▼ Activities

▼ Ending: 15 Minutes

1. **Distribute** and **project** "Building Frequency Tables". Now **take out** your pocket change and put it on your desk. **Ask** all employees to do the same. *(To spare possible embarrassment,* **comment** *that some people don't carry pocket change. Some "zeros" help in this lesson.)*

(H-30, T-30) Handout Transparency

2. **Ask** each employee to count his or her change and to wait for your instructions. When all are ready, **ask** the first employee to report the amount of change he or she has on the desk. At that point **show** all employees how to *tally* in the pre-made frequency table. If these frequencies are inadequate, **choose** others and **instruct** employees to scratch out the old ones and put in your new ones (or have them tally on a different paper).

(H-31, T-31) Handout Transparency

Distribute and **project** "Building Bar Charts".

Note: Chances are you won't have enough data to fill in a decent frequency table. Be prepared, therefore, to "make up" some data *(a phenomenon not totally unknown to statisticians)*. Start again and have employees estimate the most pocket money they generally carry.

3. **Summarize** the information from today's lesson.

4. **Say** good-bye.

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Lesson 5
Basic Statistics

▼ Lesson Description

This lesson introduces the basic tools of descriptive and inferential statistics, measures of central tendency (*mean, median, and mode*), and one measure of dispersion (*range*).

In the activities, employees begin with physical manipulatives and then progress to simple word problems. As they complete the activities, employees are introduced to the basic concepts and to the terms *mean, median, mode,* and *range.* Thus the lesson serves a valuable purpose in the overall objective of this module, namely, to increase the employees' ability to interpret and create control charts correctly.

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▼ Objectives

By completing this lesson, employees will be able to:

1. **Define** mean, median, mode, and range.
2. **Calculate** mean, median, mode and, range.
3. **Apply** their understanding of mean, median, mode, and range to word problems.

▼ Materials Needed

▼ Hardware

1. Cuisinaire rods (preferably one set per employee, but at least enough to share in groups of two or three)
2. Transparent Cuisinaire rods (to project on the overhead)
3. A balance with multiple hooks on each side or a set of yardsticks or meter sticks (one for every two employees)
4. 200 pennies (two rolls)

▼ Materials Needed

▼ Transparencies

"Exercises on the Balancing Point" (Transparency 32a and 32b)
"Steps in Finding the Average or Mean" (Transparency 33)
"Exercises in Finding the Average or Mean" (Transparency 34a, 34b, 34c)
"Additional Exercises in Finding the Average or Mean" (Transparency 35a, 35b)
"Finding the Median" (Transparency 36a, 36b)
"Steps in Calculating the Mean" (Transparency 37)
"Calculating the Median" (Transparency 38a, 38b)
"Finding the Mode" (Transparency 39)
"Finding the Range" (Transparency 40a, 40b)

▼ Handouts

"Exercises on the Balancing Point" (Handout 32a and 32b)
"Steps in Finding the Average or Mean" (Handout 33)
"Exercises in Finding the Average or Mean" (Handout 34a, 34b, 34c)

▼ Materials (cont'd)

"Additional Exercises in Finding the Average or Mean" (Handout 35a, 35b)
"Finding the Median" (Handout 36a, 36b)
"Steps in Calculating the Mean" (Handout 37)
"Calculating the Median" (Handout 38a, 38b)
"Finding the Mode" (Handout 39)
"Finding the Range" (Handout 40a, 40b)

▼ Classroom Set-up

▼ Total Time: 90 minutes

Opening- Small Groups	10 min.
First Activity- Small Groups	15 min.
Second Activity- Small Groups	15 min.
Third Activity- Small Groups	15 min.
Fourth Activity- Large Group	15 min.
Fifth Activity- Large Group	5 min.
Sixth Activity- Large Group	10 min.
Ending- Large Group	5 min.

▼ Key — Hardware, Transparencies, Handouts, Large Group, Small Groups, Discussion, Sign-in Sheet

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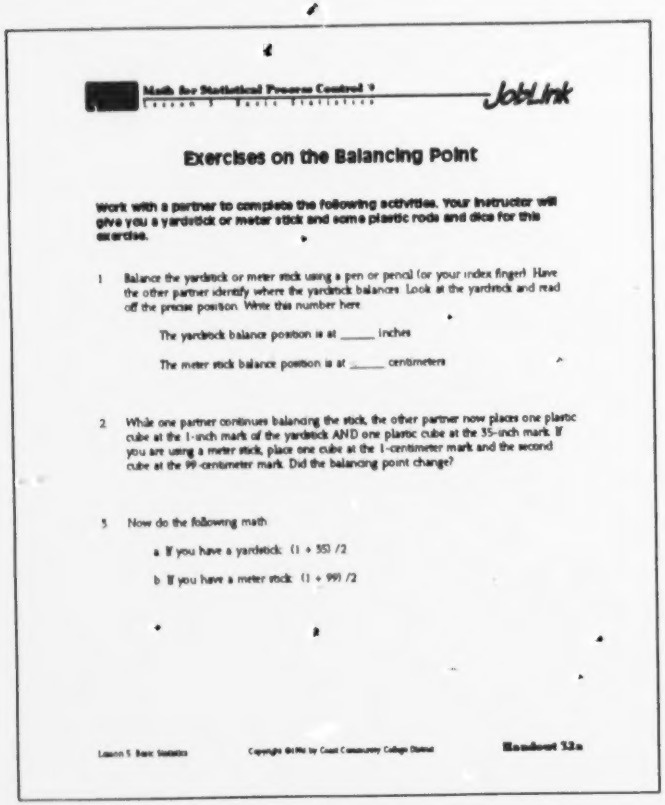

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Exercises on the Balancing Point

Work with a partner to complete the following activities. Your instructor will give you a yardstick or meter stick and some plastic rods and dice for this exercise.

1. Balance the yardstick or meter stick using a pen or pencil (or your index finger). Have the other partner identify where the yardstick balances. Look at the yardstick and read off the precise position. Write this number here.

   The yardstick balance position is at _____ inches

   The meter stick balance position is at _____ centimeters

2. While one partner continues balancing the stick, the other partner now places one plastic cube at the 1-inch mark of the yardstick AND one plastic cube at the 35-inch mark. If you are using a meter stick, place one cube at the 1-centimeter mark and the second cube at the 99-centimeter mark. Did the balancing point change?

3. Now do the following math:

   a. If you have a yardstick: (1 + 35) /2

   b. If you have a meter stick: (1 + 99) /2

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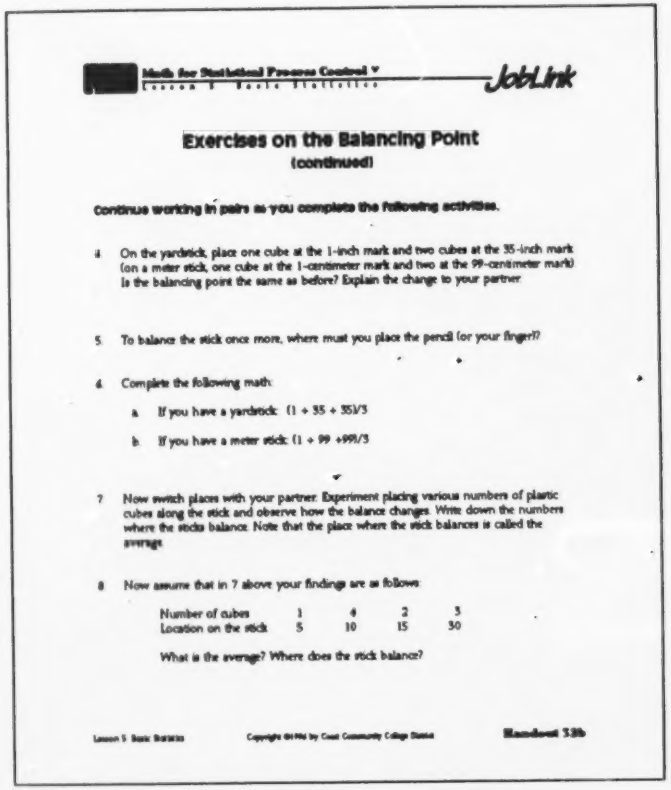
Handout 32a, Transparency 32a



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Exercises on the Balancing Point
(continued)

Continue working in pairs as you complete the following activities.

4. On the yardstick, place one cube at the 1-inch mark and two cubes at the 35-inch mark (on a meter stick, one cube at the 1-centimeter mark and two at the 99-centimeter mark). Is the balancing point the same as before? Explain the change to your partner.

5. To balance the stick once more, where must you place the pencil (or your finger)?

6. Complete the following math:

   a. If you have a yardstick: (1 + 35 + 35)/3

   b. If you have a meter stick: (1 + 99 +99)/3

7. Now switch places with your partner. Experiment placing various numbers of plastic cubes along the stick and observe how the balance changes. Write down the numbers where the sticks balance. Note that the place where the stick balances is called the average.

8. Now assume that in 7 above your findings are as follows:

Number of cubes	1	4	2	3
Location on the stick	5	10	15	30

   What is the average? Where does the stick balance?

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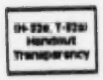
▼ Activities

▼ Opening: 10 Minutes

1. **Welcome** the group. **Discuss** the idea of the *mean* or *average* as a *balancing point*. **Explain** the balance that we observe, for example, on an old-fashioned balance or on a teeter-totter.

2. **Use** the balance to demonstrate the idea of a *mean*. **Next,** use a yardstick and small weights (or Cuisinaire rods or coins) to illustrate the physical meaning of *mean* or *average*. **Explain** that the point where the yardstick balances is the *mean*.



3. **Distribute** and **project** "Exercises on the Balancing Point". **Instruct** employees to pair off in groups of two.

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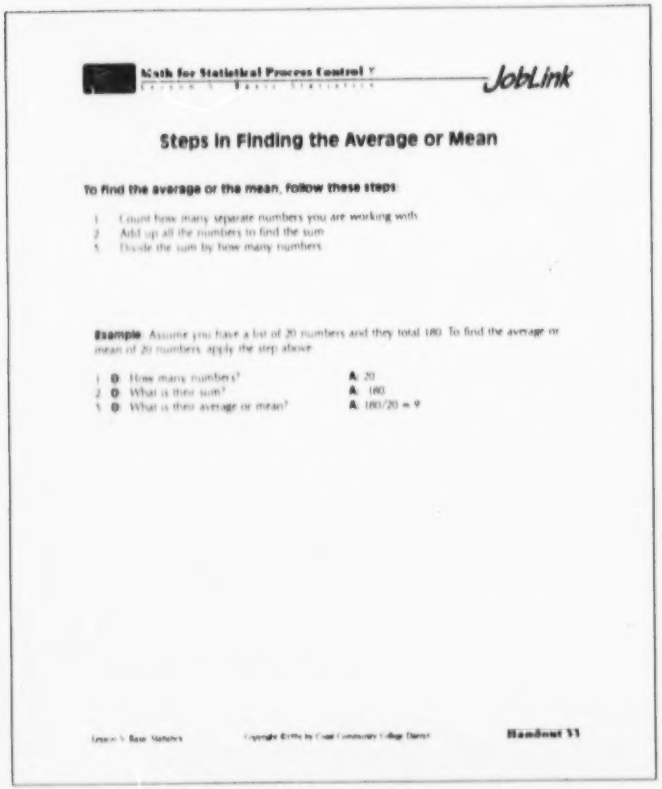

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Steps in Finding the Average or Mean

To find the average or the mean, follow these steps:

1. Count how many separate numbers you are working with.
2. Add up all the numbers to find the sum.
3. Divide the sum by how many numbers.

Example: Assume you have a list of 20 numbers and they total 180. To find the average or mean of 20 numbers, apply the step above:

1. **Q**: How many numbers? **A**: 20
2. **Q**: What is their sum? **A**: 180
3. **Q**: What is their average or mean? **A**: 180/20 = 9

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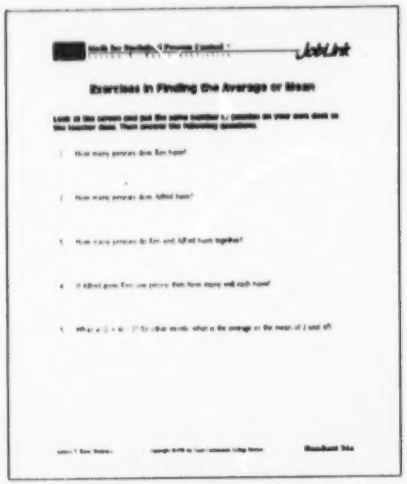
Handout 33, Transparency 33



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Exercises in Finding the Average or Mean

Look at the names and put the same number of pennies on your own desk as the teacher does. Then answer the following questions.

1. How many pennies does Ken have?
2. How many pennies does Alfred have?
3. How many pennies do Ken and Alfred have together?
4. If Alfred gives Ken one penny, then how many will each have?
5. What is 2 + 4? So in other words, what is the average or the mean of 2 and 4?

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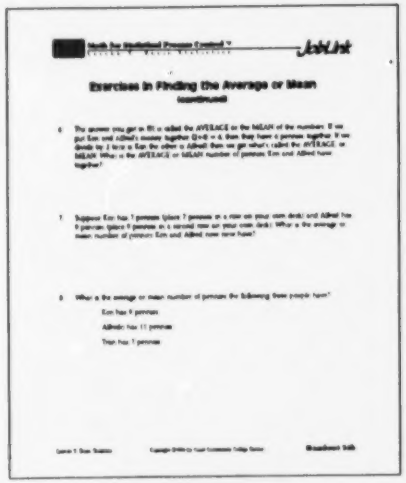

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Exercises in Finding the Average or Mean
(continued)

6. The answer you get in #5 is called the AVERAGE or the MEAN of the numbers. If we put Ken and Alfred's money together (2+4 = 6, then they have 6 pennies together. If we divide by 2 (one for Ken, the other is Alfred) then we get what's called the AVERAGE or MEAN. What is the AVERAGE or MEAN number of pennies Ken and Alfred have together?

7. Suppose Ken has 7 pennies (place 7 pennies or a row on your own desk) and Alfred has 9 pennies (place 9 pennies on a second row on your own desk). What is the average or mean number of pennies Ken and Alfred now have have?

8. What is the average or mean number of pennies the following three people have?
   Ken has 9 pennies
   Alfredo has 11 pennies
   Tran has 7 pennies

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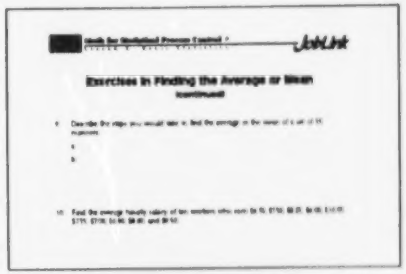

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Exercises in Finding the Average or Mean
(continued)

9. Describe the steps you would take to find the average or the mean of a set of 15 numbers.
   a.
   b.

10. Find the average hourly salary of ten workers who earn $6.75, $7.50, $8.00, $8.00, $10.00, $7.75, $7.50, $8.50, $8.00, and $9.50.

Handout 34c, Transparency 34c

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▼ Activities

▼ First Activity: 15 Minutes

1. **Distribute** "Steps in Finding the Average or Mean" and **project** it on the overhead. Also **distribute** some pennies to each employee. **Explain** that this activity will help employees understand the concept of mean.

2. **Arrange** two groups of pennies on the overhead–2 pennies in one group (call this set "Ken's money") and 4 pennies in the other (call this set "Alfred's money"). The screen should look like this:

Ken's money

Alfred's money

3. **Point out** that finding the average is essentially the same as trying to "even out" the groups of pennies so that each group has the same number of pennies.

4. **Repeat** the exercise with a group of 2 pennies and a group of 3 pennies. **Explain** the need here to split a penny in half in order to average the groups (the average of 2 and 3 is 2.5).

5. **Distribute** "Exercises in Finding the Average or Mean" and **project** these exercises on the overhead. **Lead** employees through the exercises.

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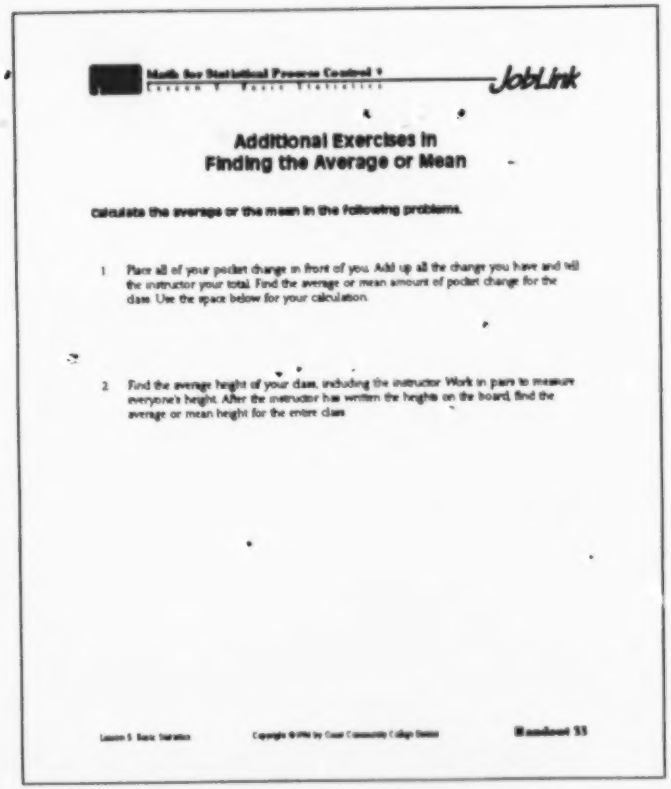

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Lesson 5: Basic Statistics

Additional Exercises in Finding the Average or Mean

Calculate the average or the mean in the following problems.

1. Place all of your pocket change in front of you. Add up all the change you have and tell the instructor your total. Find the average or mean amount of pocket change for the class. Use the space below for your calculation.

2. Find the average height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the average or mean height for the entire class.

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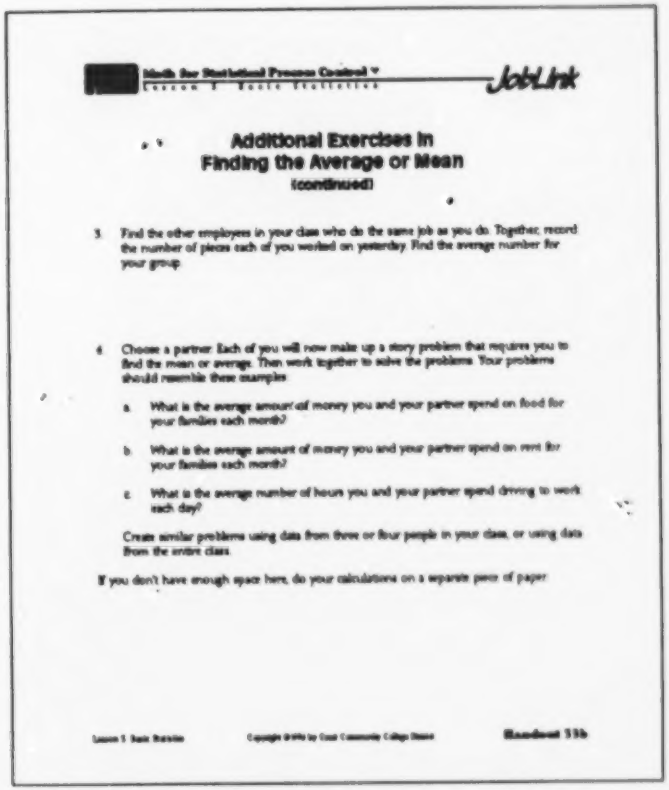
Handout 35a Transparency 35a



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Lesson 5: Basic Statistics

Additional Exercises in Finding the Average or Mean
(continued)

3. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the average number for your group.

4. Choose a partner. Each of you will now make up a story problem that requires you to find the mean or average. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the average amount of money you and your partner spend on food for your families each month?

   b. What is the average amount of money you and your partner spend on rent for your families each month?

   c. What is the average number of hours you and your partner spend driving to work each day?

   Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.

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Activities

Second Activity: 15 Minutes

1. **Tell** employees that they will now practice taking the average of numbers. **Distribute** "Additional Exercises in Finding the Average or Mean" and **project** both sheets on the overhead.

(H-33a, T-33a) Handout Transparency

2. **Explain** that you will read each exercise and then give the class time to work it out.

(H-33b, T-33b) Handout Transparency

3. **Allow** employees to work in pairs if you wish.

4. **Walk around** the room to help individuals or groups as needed. Complete as many exercises as time permits.

5. **Reinforce** the concepts of average and mean, and **close** the activity.

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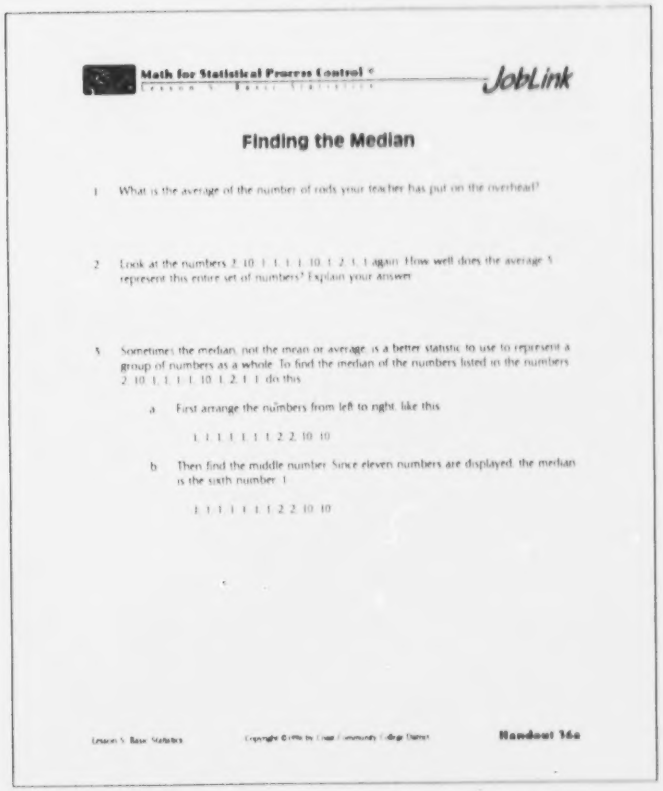

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Finding the Median

1. What is the average of the number of rods your teacher has put on the overhead?

2. Look at the numbers 2, 10, 1, 1, 1, 1, 1, 10, 1, 2, 1, 1 again. How well does the average 5 represent this entire set of numbers? Explain your answer.

3. Sometimes the median, not the mean or average, is a better statistic to use to represent a group of numbers as a whole. To find the median of the numbers listed in the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1, 1 do this:

   a. First arrange the numbers from left to right, like this:

      1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10

   b. Then find the middle number. Since eleven numbers are displayed, the median is the sixth number: 1

      1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10

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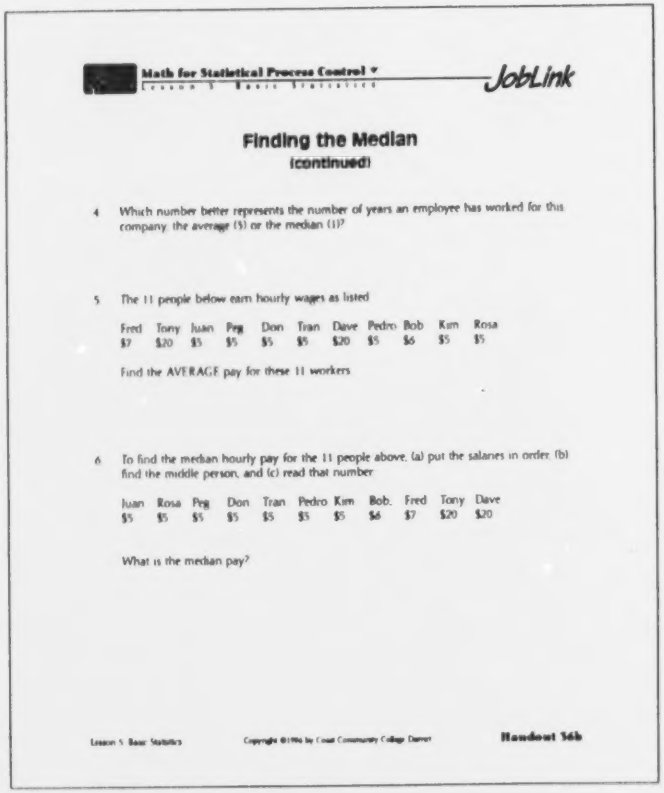
Handout 36a, Transparency 36a



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Finding the Median
(continued)

4. Which number better represents the number of years an employee has worked for this company, the average (5) or the median (1)?

5. The 11 people below earn hourly wages as listed:

Fred	Tony	Juan	Peg	Don	Tran	Dave	Pedro	Bob	Kim	Rosa
$7	$20	$5	$5	$5	$5	$20	$5	$6	$5	$5

   Find the AVERAGE pay for these 11 workers.

6. To find the median hourly pay for the 11 people above, (a) put the salaries in order, (b) find the middle person, and (c) read that number.

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

   What is the median pay?

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▼ Activities

▼ Third Activity: 15 Minutes

1. **Tell** employees that they will now learn the concept of *median.*

2. **Place** a handful of Cuisinaire rods on the overhead; choose a set that looks something like this: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1. (The idea is to show that the mean is not always a good measure of central tendency.)

3. First **ask** employees if they could find the mean of these rods. **Show** them the calculation on the board.

4. **Explain** that the median is at times a better measure of central tendency. **Refer** to the example above. **Say,** "Suppose these numbers represent the number of years 11 employees have been with the company. The average is about 3 years, but the median is one year, and the median is a truer measure of the number of years this group of 11 people has been with the company."

(H-38a, T-38a) Handout Transparency

(H-38b, T-38b) Handout Transparency

5. **Distribute** "Finding the Median" and **project** each sheet on the overhead as employees complete the problems.

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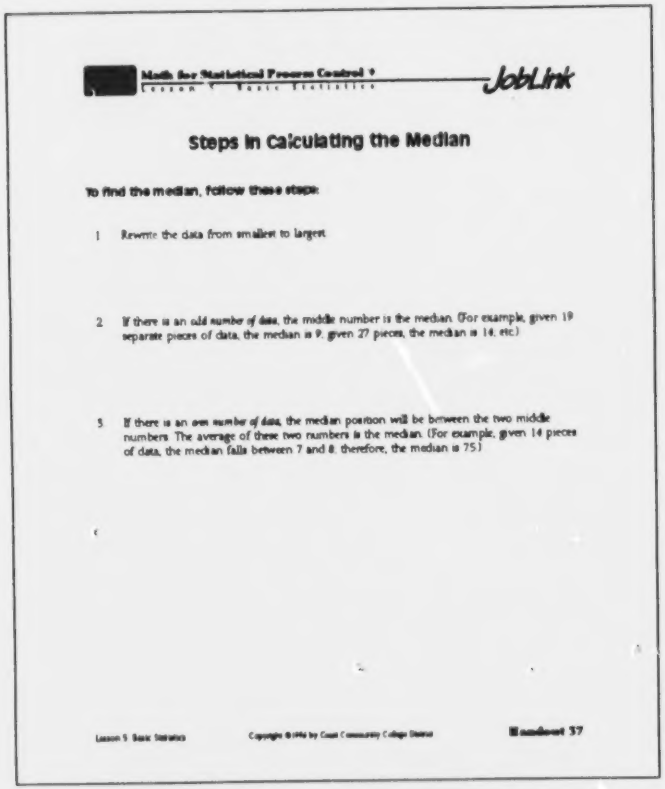

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Steps in Calculating the Median

To find the median, follow these steps:

1. Rewrite the data from smallest to largest.

2. If there is an *odd number of data*, the middle number is the median. (For example, given 19 separate pieces of data, the median is 9; given 27 pieces, the median is 14; etc.)

3. If there is an *even number of data*, the median position will be between the two middle numbers. The average of these two numbers is the median. (For example, given 14 pieces of data, the median falls between 7 and 8; therefore, the median is 7.5.)

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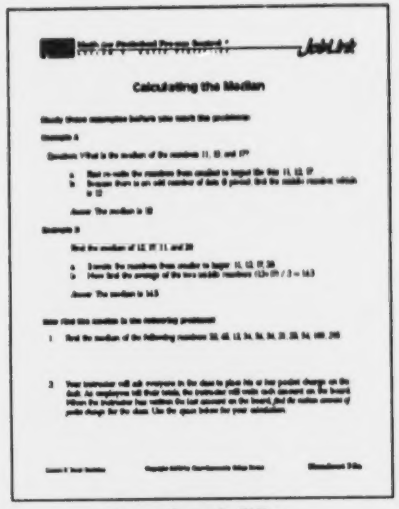
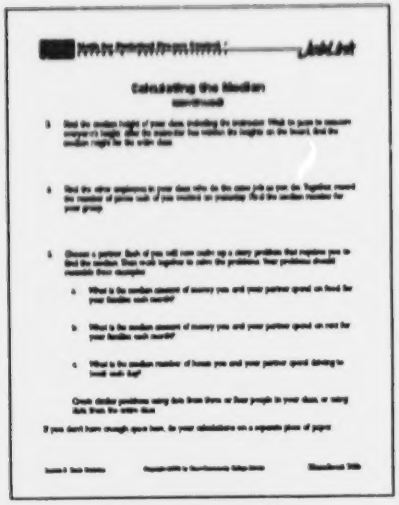


Calculating the Median

Handout 38a, Transparency 38a



Calculating the Median
(continued)

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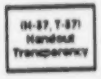
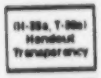
▼ Activities

▼ Fourth Activity: 15 Minutes

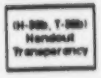
1. **Use** the same data from the Third Activity, but now **compute** the median by *formula*. Conduct this activity together as a class, not in groups.



2. **Distribute** "Steps in Calculating the Median" and **project** it on the overhead. **Explain** the steps to the class.



3. **Distribute** "Calculating the Median" and **project** both sheets on the overhead.



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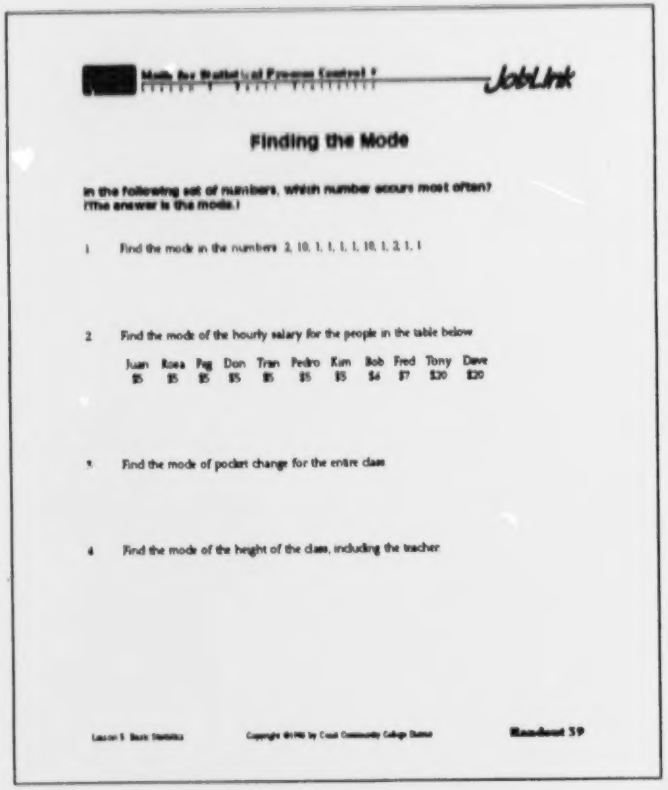

Finding the Mode

In the following set of numbers, which number occurs most often? (The answer is the mode.)

1. Find the mode in the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1

2. Find the mode of the hourly salary for the people in the table below

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$4	$7	$20	$20

3. Find the mode of pocket change for the entire class

4. Find the mode of the height of the class, including the teacher

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▼ Activities

▼ Fifth Activity: 5 Minutes

1. **Explain** that the mode is the number that occurs the most. **Tell** the class, "Mode is the easiest statistic to identify." **Repeat** the exercises in the Second, Third, and Fourth Activities–this time to identify the mode. **Place** a handful of Cuisinaire rods on the overhead. **Choose** a set that looks something like this:

   2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1

2. **Explain** that the mode provides a quick way of arriving at a measure of central tendency. **Tell** employees that the mode is not used very often in quality control.

3. **Distribute** "Finding the Mode" and **project** it on the overhead. **Lead** employees through the exercises.

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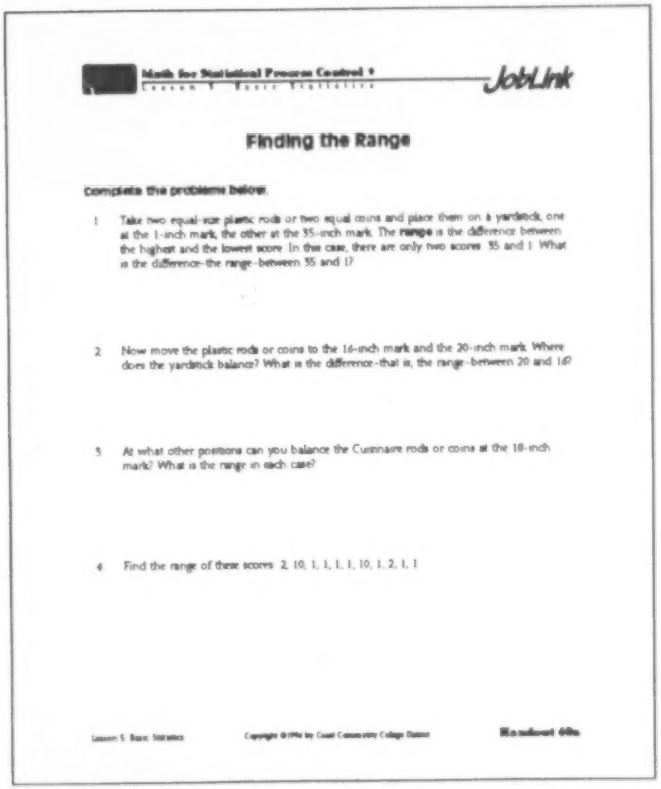

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Finding the Range

Complete the problems below.

1. Take two equal-size plastic rods or two equal coins and place them on a yardstick, one at the 1-inch mark, the other at the 35-inch mark. The **range** is the difference between the highest and the lowest score. In this case, there are only two scores: 35 and 1. What is the difference--the range--between 35 and 1?

2. Now move the plastic rods or coins to the 16-inch mark and the 20-inch mark. Where does the yardstick balance? What is the difference--that is, the range--between 20 and 16?

3. At what other positions can you balance the Cuisinaire rods or coins at the 18-inch mark? What is the range in each case?

4. Find the range of these scores: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1

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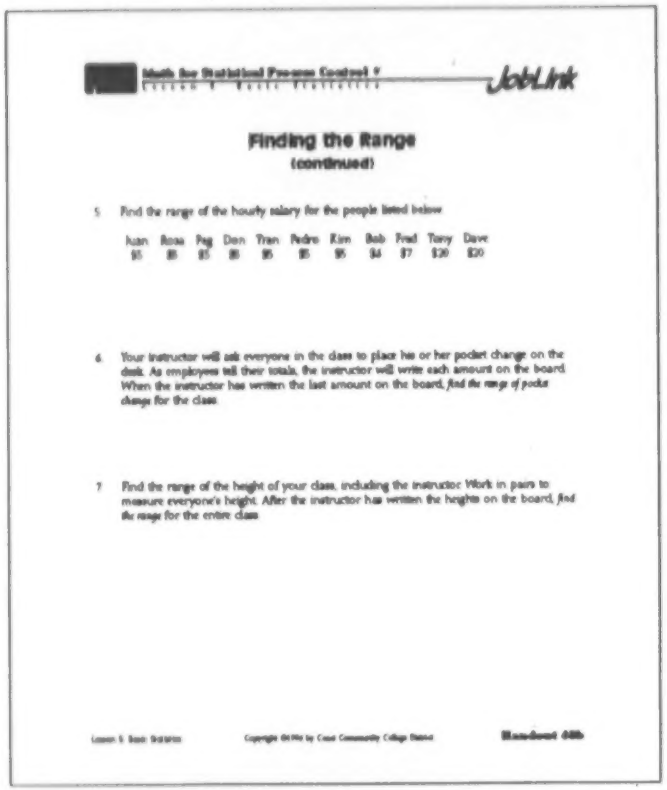

Math for Statistical Process Control ▼ JobLink

Finding the Range
(continued)

5. Find the range of the hourly salary for the people listed below.

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$4	$7	$20	$20

6. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, *find the range of pocket change* for the class.

7. Find the range of the height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, *find the range* for the entire class.

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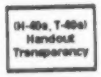
▼ Activities

▼ Sixth Activity: 10 Minutes

1. **Tell** the class, *"Range* is the simplest measure of dispersion."



2. **Distribute** "Finding the Range" and **project** it on the overhead. **Lead** employees through the problems.

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▼ Activities

▼ Ending: 5 Minutes

1. **Review** concepts of median, mean, mode and range.
2. **Ask** class how they might use these new skills back at work and at home.
3. **Say** good-bye.

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Lesson 6
Control Charts

▼ Lesson Description

This lesson begins with common examples of control processes used in everyday life (for instance, tuning an old-fashioned radio and focusing a camera) and progresses to control processes used in manufacturing operations.

All manufacturing companies try to control the quality of their processes, but quality control is not limited to manufacturing, of course. Restaurants, dental offices, supermarkets–all businesses aim for consistent quality. For manufacturers, however, quality control is especially important; indeed, manufacturing quality control is critical to the success of our national economy. This lesson helps employees appreciate their roles in and their contribution to manufacturing Statistical Process Control (SPC).

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▼ Objectives

By completing this lesson, employees will be able to:

1. **Recognize** quality control processes in everyday life.
2. **Relate** common quality control processes with manufacturing Statistical Process Control (SPC).
3. **Interpret** a control chart.
4. **Build** a control chart.

▼ Materials Needed

▼ Hardware

1. Overhead projector and screen
2. Transparency pens
3. Dice (2 dice per group)
4. Calculators
5. A ball of string
6. Blindfold

▼ Materials Needed

▼ Transparencies

"Quality Control in the World Around Us" (Transparency 41)

"Quality Control in the World Around Us- Questions" (Transparency 42)

"A Sample Control Chart" (Transparency 43)

"A Sample Control Chart Summary Sheet" (Transparency 44)

"Control Chart" (Transparency 45)

▼ Materials Needed

▼ Handouts

"Quality Control in the World Around Us" (Handout 41)

"Quality Control in the World Around Us - Questions" (Handout 42)

"A Sample Control Chart" (Handout 43)

"A Blank Control Chart Sheet" (Handout 44)

"Control Chart" (Handout 45)

▼ Classroom Set-up

▼ Total Time: 90 minutes

Opening- Large Group	15 min.
First Activity- Large Group	10 min.
Second Activity- Sm. Groups (of 3)	40 min.
Third Activity- Large Group	20 min.
Ending Activity- Large Group	5 min.

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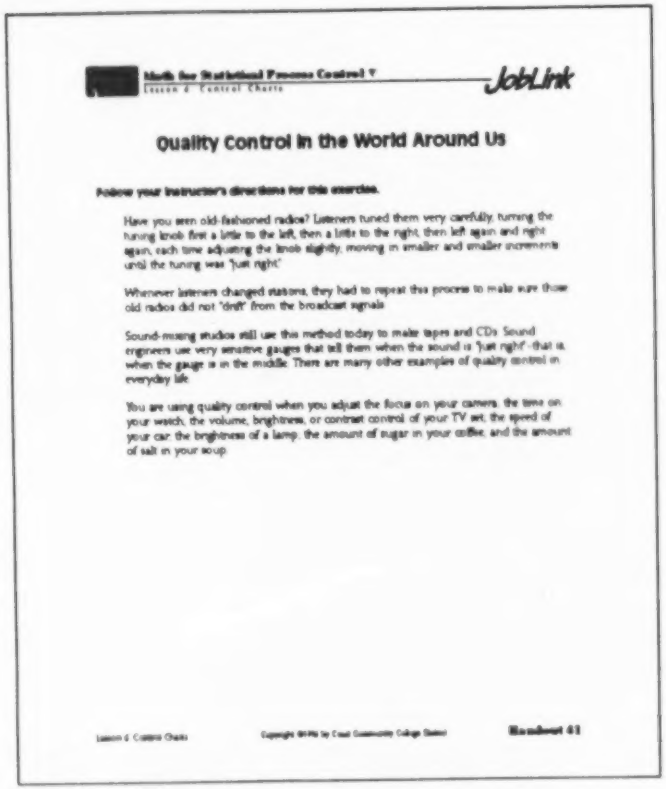


Math for Statistical Process Control ▼ JobLink
Lesson 6: Control Charts

Quality Control in the World Around Us

Follow your instructor's directions for this exercise.

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

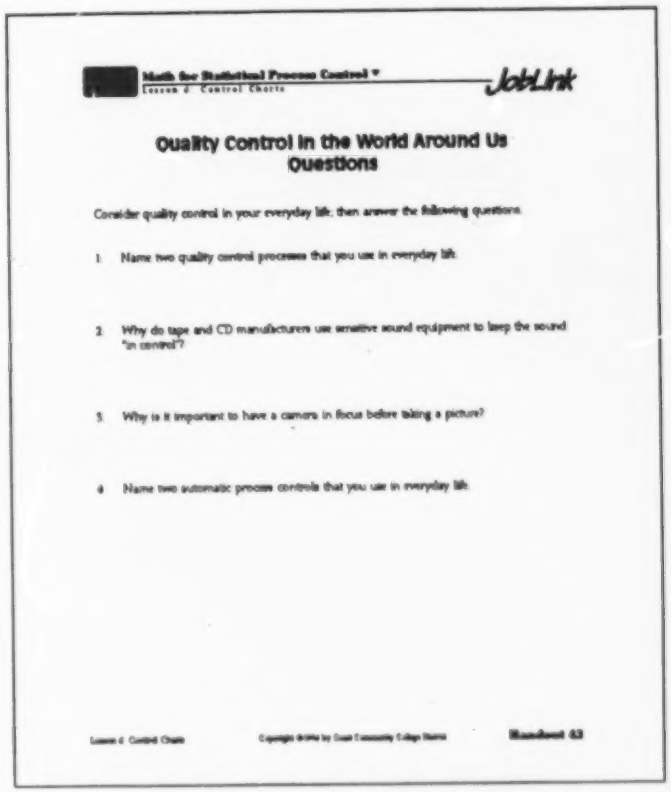
Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right" - that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera, the time on your watch, the volume, brightness, or contrast control of your TV set, the speed of your car, the brightness of a lamp, the amount of sugar in your coffee, and the amount of salt in your soup.

Lesson 6: Control Charts Copyright ©1996 by Coast Community College District Handout 41

Handout 41, Transparency 41



Math for Statistical Process Control ▼ JobLink
Lesson 6: Control Charts

Quality Control in the World Around Us
Questions

Consider quality control in your everyday life, then answer the following questions.

1. Name two quality control processes that you use in everyday life.

2. Why do tape and CD manufacturers use sensitive sound equipment to keep the sound "in control"?

3. Why is it important to have a camera in focus before taking a picture?

4. Name two automatic process controls that you use in everyday life.

Lesson 6: Control Charts Copyright ©1996 by Coast Community College District Handout 42

Handout 42, Transparency 42

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▼ Activities

▼ Opening: 10 Minutes

1. **Welcome** group.

2. **Distribute** and **project** "Quality Control in the World Around You". *Deliberately* **leave** the transparency out of focus. **Wait** until an employee points out the transparency is out of focus; then play with the adjustment knob, deliberately keeping the image out of focus by going slightly past the focus point in each direction several times. Finally, **focus** the image properly. Now **say** to the class, "Adjusting the knob on this projector is an example of *quality control*."

3. **Instruct** the class to read the Handout along with you as you **read** it aloud; stop as necessary to **explain** or **discuss** words.

4. **Distribute** and **project** "Quality Control in the World Around Us-Questions". Answer the questions.

5. **Draw** a picture of a sound gauge on the screen; **point out** that the sound is best when the needle is in the middle–the process is "in control."

180

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▼ Activities

▼ First Activity: 10 Minutes

1. **Tell** employees they are about to play a brief game. **Proceed** as follows:

2. **Ask** them to stand up. Then **ask** for four volunteers. Have the volunteers work in pairs; **instruct** each pair to hold a long piece of string so as to form a path a little narrower than a normal sidewalk. **Make** the path as long as the room will allow (say, 12 to 20 feet long).

3. **Ask** the volunteers to hold the strings taut, parallel, and close to the floor (or on the floor). (Note: If string is not available, place tiles on the floor or arrange two long tables or a row of chairs as your path.)

4. **Ask** for another volunteer to walk the path; then *blindfold* the volunteer. **Tell** him or her to walk the length of the path without touching the strings. **Instruct** the class to yell "Stop! You're out of control!" whenever the blindfolded employee touches the string.

5. Next, **ask** another volunteer to guide the person down the middle of the path. Instruct the class to cheer and applaud whenever the blindfolded employee makes it to the other side.

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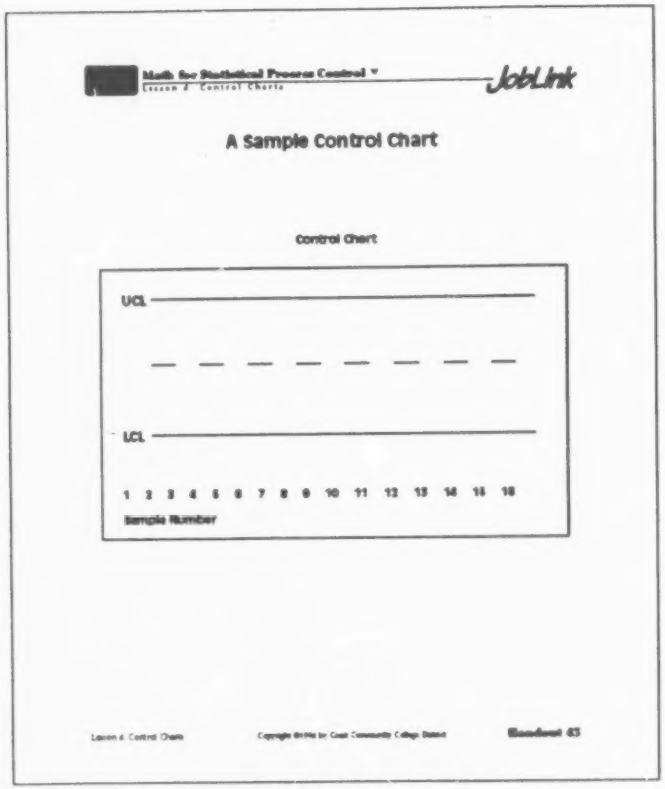

Handout 43, Transparency 43

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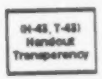
▼ Activities

▼ First Activity (continued):

6. **Explain** the parallels between this simple game and a control chart: In a manufacturing process, the control chart helps keep within the acceptable tolerances of quality. In the game, the blindfolded person is the "product" coming down the assembly line. When the group yells "Stop!" the line is stopped until the problem is fixed, until the blindfolded person is in the middle of the lane again.



7. **Distribute** and **project** "A Sample Control Chart". **Explain** the details of the control chart. **Explain** that there are x-bar charts, where x-bar (it's actually x-bar-bar, since it's the mean of the sample means, called the grand mean) is the line that shows the process is in control, and there are R (Range) control charts where the range is the in-control middle line.

8. **Point out** the following:

   a. The middle of the process is the midline of the control chart the x-bar-bar line.

   b. The lines on either side represent the two strings in the exercise:

      - **LCL**= *Lower Control Limit*. In a soda bottling operation, for example, the LCL could indicate that the bottles are being underfilled, which would certainly cause customer complaints.
      - **UCL**= *Upper Control Limit*. If the bottles are overfilled, the company loses money; furthermore, overfilling could cause a problem with the capping process.
      - **Repeat** the same procedure for the R-chart.

   c. If possible, show control chart examples from the company. If it is not possible, have a sample control chart made up to show the class.

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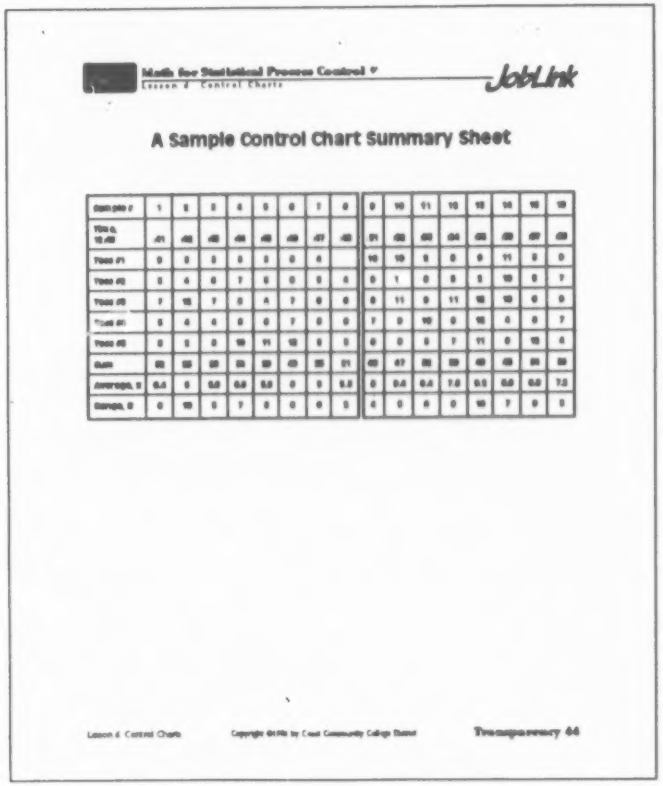
Math for Statistical Process Control ▼
Lesson 6: Control Charts
JobLink
A Sample Control Chart Summary Sheet
Lesson 6: Control Charts
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Transparency 44

Transparency 44

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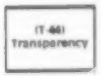
▼ Activities

▼ Second Activity: 40 Minutes

1. **Explain** to the class that the dice game "craps" provides insights into the concept of a control chart. **Describe** briefly the game of craps if you are familiar with it; if you are not, simply **tell** employees that in the game, players throw the dice and wager on the numbers that will appear (the "number" is the sum of the spots that show faceup). Thus throwing a 3 and a 5 gives the number 8.

   (Note: On average, 7 is the number that shows up most of the time. Thus we will say the system is *in control* if the average of five throws of the dice is *7 plus or minus an "error" of 1* (for a sample of 5 throws, the standard deviation is about 1.08). In other words, 6, 7, and 8 are the *in-control numbers,* and 2, 3, 4, 5, 8, 10, 11, and 12 are the *out-of-control numbers).*

2. **Tell** them you will show them the process and then will let them try the game in groups of threes.



3. **Project** "A Sample Control Chart Summary" on the overhead, and **explain** to the class that when completed, their work will look like the transparency. **Tell** employees they will:

   a. Take 16 samples of a "manufacturing process."
   b. Mark the time they take each sample.
   c. Toss the dice five times and then find:
      - The sum.
      - The average.
      - The range for each column.
   d. Repeat this process 8 times

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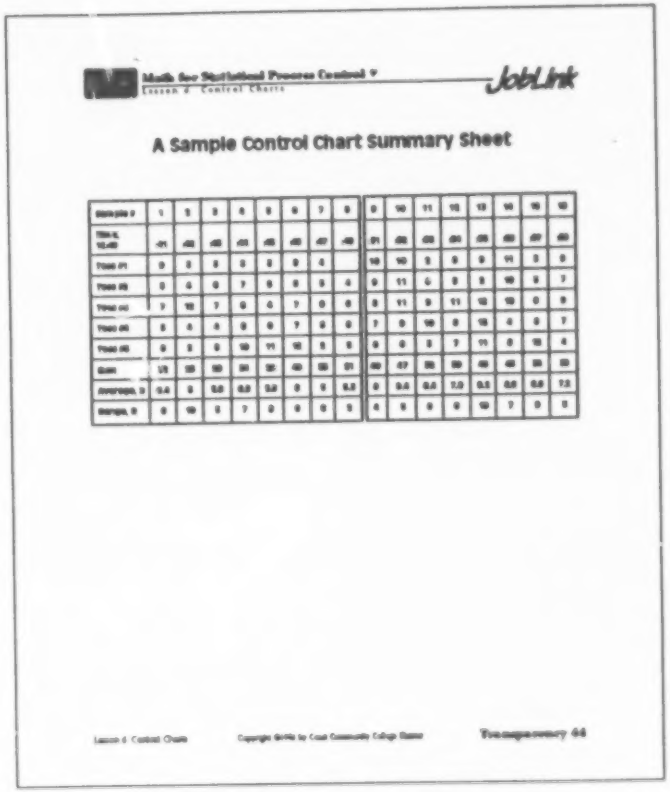

Transparency 44

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▼ Activities

▼ Second Activity (continued):

4. **Stop** when employees get to the 8th column. Now **show** them how to "load" one of the dice. (**Important:** Loading the dice is crucial to this lesson! When a machine on the assembly line "slips a gear" or has some other mechanical failure, the control chart is generally the first proof of this problem. By loading the dice, of course, the employees cause the problem. **Mention** random real-life events such as getting a flat tire when you least expect it. **Explain** that control charts are designed to identify such problems.) Load the dice as follows:

    a. **Turn** one die to the face with 5 dots.

    b. **Tape** a tiny bit of sticky paper on the middle dot, covering the middle dot and thus turning the "5" into a "4." Now there are two 4s!

    c. Next, using an overhead pen mark an extra dot on the "3" face of the same die making it into a "4."

    d. Now this die has the following faces: 1, 2, 4, 4, 4, 6, instead of the usual 1, 2, 3, 4, 5, 6.

(T-44) Transparency

5. When you finish, **project** "A Sample Control Chart Summary" on the overhead. **Ask** an employee to come to the front to help you.

6. With the help of the employee, **demonstrate** how to fill out the chart:

    a. **Record** the time that the process starts–first the hour next to the word "Sample" and then under the number 1.

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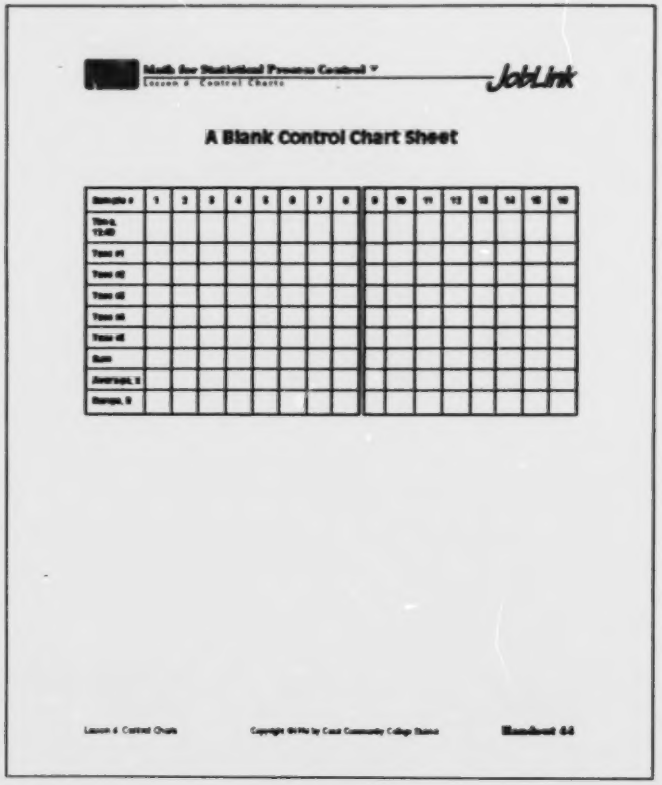

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▼ Activities

▼ Second Activity (continued):

b. **Ask** the employee to roll the dice on the table, and **record** the sum in the first position: Sample #1, Toss #1.

c. **Proceed** to fill in the first column; **explain** that this is the first of 16 throws.

d. **Find** the average of the first column (add the five numbers and divide by 5). Make sure the employees follow your procedure!

Find the Range using this formula:

Range = Maximum Value – Minimum Value

6. **Ask** employees to form groups of three.

7. **Distribute** "A Blank Control Chart Sheet" to each group.

8. **Instruct** employees to fill in the first 8 columns using the same procedure you used. **Walk around** the room to help each group.

9. When all 8 columns are filled, **stop** the groups and **direct** employees to "load" the dice.

10. **Repeat** the process with the loaded dice. Fill in the rest of the chart beginning with the ninth column.

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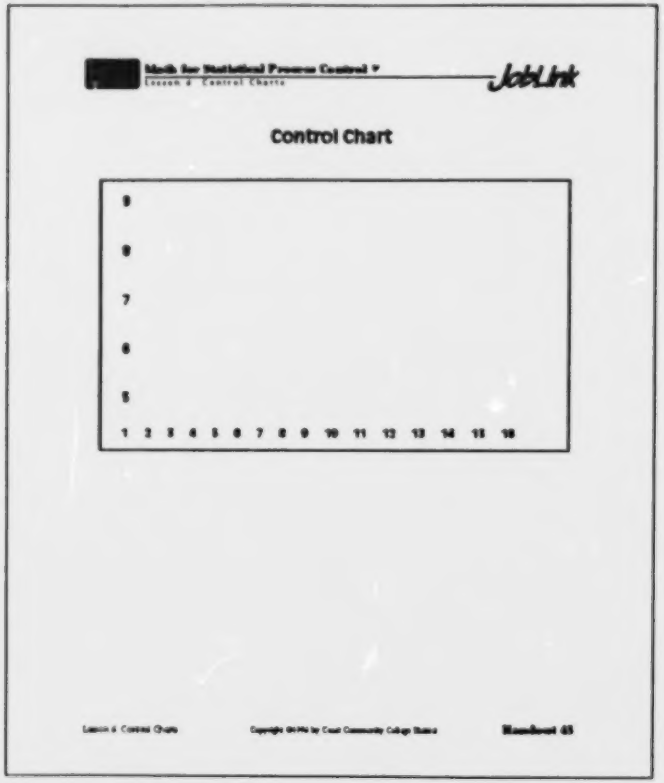

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▼ Activities

▼ Third Activity: 25 Minutes

1. Immediately after completing the Second Activity, **distribute** "Control Chart" to each group, and **project** it on the overhead.

2. **Direct** the employees to plot the 16 means on the control chart. **Start** them off by plotting the first few points.

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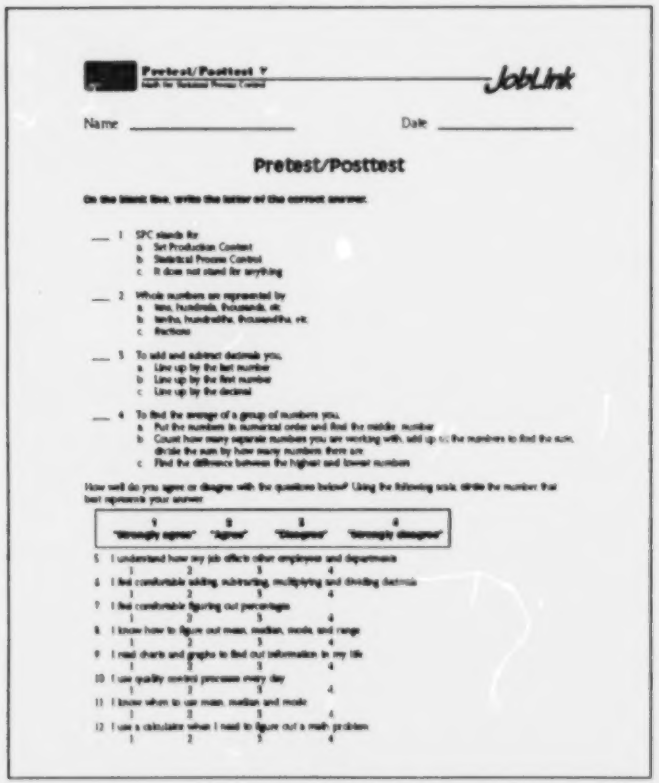

Pretest/Posttest ▼ JobLink

Name _____ Date _____

Pretest/Posttest

On the blank line, write the letter of the correct answer.

___ 1. SPC stands for
a. Set Production Content
b. Statistical Process Control
c. It does not stand for anything

___ 2. Whole numbers are represented by
a. tens, hundreds, thousands, etc.
b. tenths, hundredths, thousandths, etc.
c. fractions

___ 3. To add and subtract decimals you,
a. Line up by the last number
b. Line up by the first number
c. Line up by the decimal

___ 4. To find the average of a group of numbers you,
a. Put the numbers in numerical order and find the middle number
b. Count how many separate numbers you are working with, add up all the numbers to find the sum, divide the sum by how many numbers there are
c. Find the difference between the highest and lowest numbers

How well do you agree or disagree with the questions below? Using the following scale, circle the number that best represents your answer.

1 "Strongly agree"	2 "Agree"	3 "Disagree"	4 "Strongly disagree"

5. I understand how my job affects other employees and departments
1 2 3 4
6. I feel comfortable adding, subtracting, multiplying and dividing decimals
1 2 3 4
7. I feel comfortable figuring out percentages
1 2 3 4
8. I know how to figure out mean, median, mode, and range
1 2 3 4
9. I read charts and graphs to find out information in my life
1 2 3 4
10. I use quality control processes every day
1 2 3 4
11. I know when to use mean, median and mode
1 2 3 4
12. I use a calculator when I need to figure out a math problem
1 2 3 4

Form

Learner Assessment Form ▼ JobLink
Math for Statistical Process Control

Your Instructor will complete these questions

A. Course Number _____ Instructor _____
Site Location _____ Class Schedule _____
B. Who completed the level testing and when? _____ Module _____
☐ The learner
☐ The learner, with assistance from instructor or project staff
☐ An instructor or project staff member with information provided by the learner
☐ Other (Please specify) _____
C. Date form completed ___/___/___

1. Name: _____
2. Address: _____
_____
3. Phone Number: ( ) _____
4. Social Security Number:
_____-_____-_____
5. In the future, do you plan to take any of the following courses?
(Mark one for each line)

	Plan to Take	Do Not Plan to Take
A basic skills course in reading, writing, or math	☐	☐
A course in using English (such as ESL)	☐	☐
A computer course	☐	☐
A GED course or the GED exam	☐	☐
Courses to get an occupational certificate	☐	☐
A job training course	☐	☐
Courses leading to a 2-year or 4-year college degree	☐	☐
A home-study course	☐	☐

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JobLink

YES NO

Page 2

Learner Assessment Form

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▼ Activities

▼ Ending: 15 Minutes

1. **Review** the main points from the lesson. Make sure to emphasize the importance of quality control in the workplace.
2. **Ask** "Where could or do you use these concepts at work?"
3. **Summarize** all six lessons.

4. **Distribute** "Posttest" and "Learner Assessment". Have employees complete.
5. **Say** good-bye.

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Name _____ Date _____

Pretest/Posttest

On the blank line, write the letter of the correct answer.

___ 1. SPC stands for:
   a. Set Production Content
   b. Statistical Process Control
   c. It does not stand for anything

___ 2. Whole numbers are represented by:
   a. tens, hundreds, thousands, etc.
   b. tenths, hundredths, thousandths, etc.
   c. fractions

___ 3. To add and subtract decimals you,
   a. Line up by the last number
   b. Line up by the first number
   c. Line up by the decimal

___ 4. To find the average of a group of numbers you,
   a. Put the numbers in numerical order and find the middle number
   b. Count how many separate numbers you are working with, add up all the numbers to find the sum, divide the sum by how many numbers there are.
   c. Find the difference between the highest and lowest numbers.

How well do you agree or disagree with the questions below? Using the following scale, **circle** the number that best represents your answer:

1 "Strongly agree"	2 "Agree"	3 "Disagree"	4 "Strongly disagree"

5. I understand how my job effects other employees and departments.
   1 2 3 4
6. I feel comfortable adding, subtracting, multiplying and dividing decimals.
   1 2 3 4
7. I feel comfortable figuring out percentages.
   1 2 3 4
8. I know how to figure out mean, median, mode, and range.
   1 2 3 4
9. I read charts and graphs to find out information in my life.
   1 2 3 4
10. I use quality control processes every day.
   1 2 3 4
11. I know when to use mean, median and mode.
   1 2 3 4
12. I use a calculator when I need to figure out a math problem.
   1 2 3 4

Your instructor will complete these questions

Instructor _____

A. Course Number _____
Site Location _____

Class Schedule _____

Module _____

B. Who completed this form? **(MARK ONE BOX)**

- ❑ The learner
- ❑ The learner, with assistance from instructor or project staff
- ❑ An instructor or project staff member with information provided by the learner
- ❑ Other (Please specify)

_____

C. Date form completed: ____/____/____

1. **Name:** _____

2. **Address:** _____

_____

3. **Phone Number:** ( ) _____

4. **Social Security Number:**

_____-_____-_____

5. **In the future, do you plan to take any of the following courses?**

(Mark one for each line)

	Plan to Take	Do Not Plan to Take
A basic skills course in reading, writing, or math	❑	❑
A course in using English (such as ESL)	❑	❑
A computer course	❑	❑
A GED course or the GED exam	❑	❑
Courses to get an occupational certificate	❑	❑
A job training course	❑	❑
Courses leading to a 2-year or 4-year college degree	❑	❑
A home-study course	❑	❑

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Since this course began, have you:

(Mark one for each line)

	YES	NO
Learned what you wanted to learn in this course?	❑	❑
Changed your educational or career goals?	❑	❑
Had more responsibility added to your job?	❑	❑
Moved to a shift you prefer?	❑	❑
Switched from part-time to full-time?	❑	❑
Received a pay raise?	❑	❑
Been promoted?	❑	❑
Received an award, bonus, or other special recognition on your job?	❑	❑
Received your GED?	❑	❑
Applied for a new job?	❑	❑
Started a new job at another company?	❑	❑
Been laid off?	❑	❑
Left your job for any other reason? (Please Specify)	❑	❑

7. **Please rate your ability to perform each of the following activities.**

(Please mark one response for every activity)

	Poor	Fair	Good	Excellent
Read English	❑	❑	❑	❑
Understand English	❑	❑	❑	❑
Speak English	❑	❑	❑	❑
Write in English	❑	❑	❑	❑
Work as part of a team	❑	❑	❑	❑
Use math	❑	❑	❑	❑
Solve problems/use reasoning	❑	❑	❑	❑

Thank you. You have completed this form.
Please return it to your instructor.

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Instructor _____
Class Schedule _____
Module _____

Your instructor will complete these questions

A. Course Number _____
Site Location _____

B. Who completed this form?
(MARK ONE BOX)

- ❑ The learner
- ❑ The learner, with assistance from instructor or project staff
- ❑ An instructor or project staff member with information provided by the learner
- ❑ Other (Please specify)

_____
_____

C. Date form completed: ___/___/___

1. **Name:** _____
2. **Address:** _____

_____

3. **Phone Number:** ( ) _____
4. **Social Security Number:**

_____-_____-_____

5. **Age:** _____
6. **Were you born in the United States?**
   ❑ Yes ❑ No
7. **Sex:** ❑ Male ❑ Female
8. **Race: (Mark One Box)**
   - ❑ White
   - ❑ Black (African American)
   - ❑ Asian or Pacific Islander
   - ❑ American Indian or Alaskan Native
   - ❑ Hispanic
   - ❑ Other (Please specify):

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_____

9. **Is English the language that is spoken most often in your home?**
   ❑ Yes ❑ No
10. **How many years of school have you completed?** _____

    Of these, how many in the U.S.? _____
    In any other country? _____
11. **Are you a union member?**
    ❑ Yes– What is the name of your union?

    _____

    ❑ No
12. **Please rate your ability to perform each of the following activities.**

(Please mark one response for every activity)

	Poor	Fair	Good	Excellent
Read English	❑	❑	❑	❑
Understand English	❑	❑	❑	❑
Speak English	❑	❑	❑	❑
Write in English	❑	❑	❑	❑
Work as part of a team	❑	❑	❑	❑
Use math	❑	❑	❑	❑
Solve problems/use reasoning	❑	❑	❑	❑

13. **Do you have a job?**
    - ❑ Yes, employed
    - ❑ Yes, on temporary layoff

    → *Go to next page*

    - ❑ No, retired
    - ❑ No, not employed

    → STOP

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Thank you. You have completed this form. Please return it to your instructor.

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Please answer questions 14-18 for the job that allows you to take this course.

14. Name of company or employer:

_____

15. Job Title:

_____

16. On average, how many hours per week do you work on this job?

_____ - _____ Hours per week

17. How much do you earn at this job?
(Write amount and mark one box)

$_____ ❑ Per hour ❑ Per year

18. Do you get any of the following benefits at this job?

(Mark one for each line)

	Yes	No
Paid vacation	❑	❑
Paid sick leave	❑	❑
Paid holidays	❑	❑
Health insurance	❑	❑

19. How long have you worked at this job?

_____ - _____ and _____ - _____
years months

20. At your job, do you need to do any of the following?

(Mark one for each line)

	Yes	No
Read instructions	❑	❑
Receive spoken instructions in English	❑	❑
Speak English	❑	❑
Work as part of a team	❑	❑
Write in English	❑	❑
Use math	❑	❑
Solve problems/use reasoning	❑	❑

21. Do you work at more than one job?

❑ Yes ❑ No

Thank you. You have completed this form. Please return it to your instructor.

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Getting to Know You

In this exercise you'll get to know your classmates better!

Use the questions below to interview a partner. Then your partner will interview you! At the end of class, you will use the answers on this filled-out worksheet to introduce your partner to the class. Then your partner will introduce you!

First name _____ Last name _____

Nickname ("friends call me...") _____

Three coworkers names _____

_____ _____

Mother's name _____

Father's name _____

Husband's or wife's name _____

Children's names

_____ _____

_____ _____

Favorite foods _____

Favorite singer _____

How did you hear of this company? _____

_____

How long have you worked at this company? _____

Name of supervisor _____

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My Job Is...

Answer the questions below so that you can discuss your job with the group.

1. What is your job title?

2. What department do you work in?

3. What is the name of each part you make or assemble?

4. Where does the part you work on come from? (Which department or coworker?)

5. After you finish your work, where do you send the part you work on?

6. What happens if the part you get is not made correctly? What if you cannot work on it or you have to fix it first? What do you say to the person who sends you the part? Do you send the bad part back?

7. Do you tell your boss when you get a bad part? What do you say?

8. Do you ever have bad parts sent back to you because they weren't made right? About how many parts are returned to you in one week?

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The Company Team

1. What is the name of your company?

2. What is the name of the President of your company?

3. What is the name of the visitor today?

4. What products does your company make?

5. What are these products used for?

6. Have you ever used one of these products yourself?

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Reading and Writing Numbers

In this lesson you will learn (1) to read and write numbers, (2) to add, subtract, multiply, and divide whole numbers, and (3) to take the square root of a number.

1. In our number system, we write numbers so that each **place** tells you *"How many* **ones?"** *"How many* **"tens?"** And so on.

   For example, the number 34 means that you have 3 tens ("30") and 4 ones ("4"). Thus 34 = 30 + 4. We read this number as "Thirty-four." *Thirty* means "3 **tens**" and four means "4 **ones**."

   Note that the first place is "ones" and the second place is "tens." In other words, each *place* represents a specific number value.

2. The system allows you to express larger numbers by *adding more places.* After "tens" comes "hundreds:"

   $$234 = 200 + 30 + 4$$

   Now you have "Two hundred thirty-four." The *Two hundred* means "2 **hundreds**"; the rest is the same as in the example above.

3. And after "hundreds" comes "thousands":

   $$5{,}234 = 5000 + 200 + 30 + 4$$

   Now you have "Five thousand two hundred thirty-four." The *Five thousand* means "5 **thousands**," and the rest is the same as in the example above.

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Your Turn!

Complete the following exercises:

1. Break down the number 67 into tens and ones: 67 = _____ + _____

2. Read the following number aloud: 467

3. Break down 467 into hundreds, tens, and ones: 467 = ___ + ___ + ____

4. Jim weighs 195 pounds (say, "one hundred ninety-five pounds"). He could write his weight like this: 100 + 90 + 5

   How much do **you** weigh? Write your weight in groups: ____ + ____ + ____

5. Now write your weight in the usual way (for example, 195): _____

6. How do you say this number? Write it in words:

   _____

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Addition of Whole Numbers

Complete the following exercises.

1. Use numbers to express O + OO = OOO.

2. Use circles to write the meaning of 8 + 5.

3. What does 12 + 5 mean? Sometimes we write this as:

$$\begin{array}{r} 12 \\ +\ 5 \\ \hline \end{array}$$

4. Add: 400 + 52 + 19

5. Add: 1,239 + 542 + 95 + 1

6. Now try adding the following:

$2 + 3 =$

$15 + 17 =$

$551 + 22 =$

$702 + 1259 + 55 + 1 =$

Remember: Write the numbers you are adding one below the other, and then add the numbers in each column starting from the right.

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Subtraction of Whole Numbers

Complete the following exercises.

1. Use numbers to express OOO - OO = O

2. Use circles to write the meaning of 8 - 5.

3. What does "12 - 5" mean? Sometimes we write this as:

$$\begin{array}{r} 12 \\ -5 \\ \hline \end{array}$$

4. Subtract: 400 - 52

5. Subtract: 1,239 - 542

6. Now try these:

12 - 3 =

35 - 17 =

551 - 22 =

702 - 259 =

Remember: Write the numbers you are subtracting one below the other, and then subtract the numbers in each column starting from the right.

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Addition and Subtraction Word Problems

As you read the following "word problems," *search for the basic arithmetic information.* Don't be fooled by the extra information! Follow the example:

Example:

Juan Juarez makes $300 per week and his wife Irma makes $150 per week. Together, how much money do Juan and Irma make each week?

Juan makes	$300.00
Irma makes	+150.00
	$450.00

Answer: The Juarez family makes $450.00 each week.

1. I drive a Toyota Corolla. My mother drives a Honda Accord, and my father prefers to drive an Oldsmobile. Our next-door neighbors have a pickup and a Honda Civic. Our upstairs neighbors have two cars.

   How many cars will you see parked in front of our apartment complex when we are all home?

2. Ask the person sitting on your right how many people are sitting to his/her right. Ask the person sitting on your left how many people are sitting to his/her left. Now find *the total number of people sitting in your row.*

3. You have $1,500 in your checking account. Today is payday, and you receive $1,000 in your paycheck. After work, you spend $105 for groceries. After shopping, you decide to deposit the rest of your paycheck into your checking account. How much money do you have in the account after you make your deposit?

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Multiplication of Whole Numbers

Multiplication

1. Use numbers to express
   OOOOOO
   OOOOOO
   OOOOOO

2. Use circles to write the meaning of 8 x 5.

3. What does 12 x 5 mean? Sometimes we write this as

   12
   x 5

4. Multiply 400 x 52:

   400
   x 52

5. Now try the same problem with a calculator. Ask for help if necessary!

6. Multiply using a calculator: 1,239 x 542 x 95 x 2

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Division Problems

Complete the following exercises.

1. Use circles to express 8 / 2

2. Use circles to write the meaning of 8 / 5

3. Divide: 400 / 52 =

4. Divide: 1,239 / 542 =

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Division Word Problems

As you read the following word problems, *search for the basic arithmetic information.* Don't be fooled by the extra information! Follow the example:

Example:

In the Juarez family, Juan makes $300 per week and his wife Irma makes $150 per week. What is the difference between Juans pay and Irmas pay?

Answer: $300 - $150 = $150. The difference in pay is $150.

But we can also say that Juan earns twice as much as Irma–or that he earns 2 times what Irma earns. Note the arithmetic here:

$300/$150 = 2

Thus Juan earns *2 times as much* as Irma earns.

Problems

1. Today is payday and you receive $1,200 in your paycheck. If you spend half of it for groceries and rent, how much of your pay do you have left?

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Square Roots

1. What is the square root of $\sqrt{25}$

2. $\sqrt{25} + \sqrt{36} =$

3. What is the square root of $\sqrt{75}$

4. Wallpaper border needs to be ordered for the Johnson's kitchen. The room is 20' x 15' x 20' x 15'. How much wallpaper border do you need to order?

5. The Juarez family wants to fence in a yard that is exactly square. The area of the yard is 225 square feet. How much fencing is the Juarez family going to need?

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Decimal Numbers

1. What does the number .67 mean?

   .67 = _____ + _____

2. How do you read/write the number .67?

3. What does the number 4.67 mean?

   4.67 = ___ + ___ + ____

4. How do you read/write the number 4.67?

Find your own examples of decimal numbers, and repeat the exercises above.

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Decimal Numbers: Adding and Subtracting

1. What does 1.2 + .5 mean?

$$\begin{array}{r} 1.2 \\ +\ .5 \\ \hline \end{array}$$

2. Add: 4.00 + 5.2 + .19.

$$\begin{array}{r} 4.00 \\ +\ 5.2 \\ +\ .19 \\ \hline \end{array}$$

3. Add: 12. 39 + 54. 2 + .95 + 10

4. What does 1.2 – .5 mean? How do you write this?

5. Subtract: 4.00 – 5.2

6. Subtract: 12.39 – 5.42

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Decimal Numbers: Addition and Subtraction Word Problems

Complete the following exercises. Follow the example.

Example:

Juan Juarez makes $225.50 per week and his wife Irma makes $150.75 per week. How much money do Irma and Juan earn each week?

Juan makes =	$225.50
Irma makes =	$150.75
	$376.25

Answer: Irma and Juan make $376.25 each week.

1. You have $1,500.50 in your checking account. Today is payday and you receive $1,245.50 in your paycheck. On your way home, you spend $105.37 for groceries. Then you decide to deposit the rest of your paycheck into your checking account.

   How much money do you have in your account after your deposit?

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Decimal Numbers: Multiplying

Complete the following exercises.

1. 1.2 x 6 means 1.2 + 1.2 + 1.2 + 1.2 + 1.2 + 1.2. The sum is 7.2 (add the numbers to see for yourself!).

   Instead of adding all these numbers, you can multiply two numbers, as follows:

   1.2
   x 6
   7.2

   As before, the answer is 7.2.

2. Multiply: 4.25 x 52

   4.25
   x 52

3. Now repeat #2 above but this time use a calculator. If you don't know how to use a calculator, ask someone in your group who does, or ask your instructor. You will learn how to use a calculator in the next worksheet.

   Multiply using your calculator: 4.25 x 52

4. Multiply: 12.39 x 5.42

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Using the Calculator

Use your calculator to solve the following problems. Write the answers after the equals sign.

1. 3 x 4 =
2. 30 x 40 =
3. 300 x 400 =
4. 3,000 x 4,000 =
5. 30,000 x 40,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

Now use your calculator to compute the following divisions. Write your answers after the equals sign.

1. 3/4 =
2. 3/40 =
3. 3/400 =
4. 3/4,000 =
5. 3/40,000 =
6. 3/400,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

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Decimal Numbers: Dividing

1. Use circles to express 10 ÷ 2.5

2. Use circles to write the meaning of 8 ÷ 5.

3. Divide: 400 ÷ 52 =

4. Divide: 1,239 ÷ 542 =

5. Juan Juarez makes $325.75 per week and his wife Irma makes $155.80 per week. They divide their combined pay into 3 equal parts: one part for rent, one part for food, and one part for all other expenses.

   How much do Irma and Juan spend on rent?

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Percents

1. Pick a plastic square flat and count the number of small squares in it. (Or simply draw a large square on your paper and divide each side into ten parts. Now you have a 10x10 square.)

2. Cover 25 of the small squares with the small dice. (If you are working with pencil and paper, shade in 25 of the small squares.)

3. How many squares are shaded? ___ How many squares total? ____

4. We can write the above in several different ways:

   25 squares per 100 squares
   25 per 100
   25/100
   25%
   .25

   All these statements mean the same thing: namely, *25 squares out of 100 squares.* This is the same as *one-fourth of the large square* **or** *1 out of four* **or** 1/4 **or** 1 ÷ 4.

   Use your calculator to perform this division: First press 1, then the division sign (÷), then 4, and finally the equals sign (=). Answer: .25 = 25%.

5. Now take the 25 small plastic squares off the flat and put just 10 of them back on the flat. How do we write this new arrangement?

   per _____ or _____/_____ or _____ % or .10

6. Now repeat exercises 1 to 4 by covering the flat (or flats) with the following number of small squares or dice: 5, 7, 50, 90, 99, 100, 125, 200.

7. Can you repeat exercises 1 to 5 by using a circle instead of a flat? Which percents are easy to measure? Which are hard?

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Percents
(Continued)

Use your calculator to answer the following division problems:

1. 20/ 100 =
2. 2/ 10 =
3. 200/ 1,000 =
4. 2,000/ 10,000 =
5. 20,000/ 100,000 =

What pattern do you notice in the above answers?

6. Ken pays $200 per month for food. His pay each month is $1,000. What percent of Ken's pay does he spend for food?

   200 per 1000 **or** 200/1000 **or** _____%

7. If you cover one half of the plastic flats with small dice (squares), then you are covering _____% of the flat.

8. If you pay 7% state sales tax, that means that for every dollar you spend, you have to pay the state ___.

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Percents
(Continued)

To solve word problems involving percents, follow the steps below this sample problem:

Sample Problem

At the grocery store, Mary purchases a carton of milk for $1.59 and a pound of potatoes for $1.99. The sales tax is 7.75%. What is the total that Mary pays for her purchases?

Step-by-Step Solution

Step 1: Understand and Interpret the Problem

This problem has three parts:

a. Add Mary's individual purchases to get a *subtotal* (in dollars).
b. Compute the tax–*in dollars*–that she must pay on her purchases.
c. Add the tax, *in dollars,* to the dollar amount of her purchases (the total will be her *total expense).*

Note that Parts a and c are simple addition. Part b is a percent computation.

Step 2: Add the Individual Purchases

Add Mary's individual purchases–in this case, $1.59 + $1.99 = $3.58. This is the *subtotal,* the number on which you must calculate the sales tax.

Step 3: Compute the Tax in Dollars

a. *Convert the Percent to a Decimal.* To figure out the tax in dollars, you must first convert the sales tax, which is 7.75%, to a decimal number. The 7.75% tax can be expressed as 7.75/100 **or** .0775.
b. *Use the Decimal to Compute the Dollar Amount.* Multiply.0775, the converted percent, by the subtotal: $3.58 x .0775 = $0.277.

Step 4: Add the Dollar Tax to the Dollar Subtotal

Mary's total grocery expense is $3.58 + $0.277 = $3.587, *rounded* to $3.59.

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Percents
(Continued)

Dan's credit card account balances are as follows:

Account	Interest Percent	Current Balance
Citibank Visa	18.94%	$400.01
Discover	14.98%	$398.90
Citibank MasterCard	19.98%	$401.34

Question: If you were Dan, which account would you pay off first?

Question: How much interest will Dan pay on each balance?

To calculate Dan's interest on these balances, convert each interest percent to a decimal, and multiply each balance by that decimal amount:

Visa: 18.94/100 x $400.1 =
Discover: 14.98/100 x $398.90 =
MasterCard: 19.98/100 x $401.34 =

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Percents
(Continued)

Work with a partner to solve the following problem. Ask your instructor for help if necessary.

In his will, Mr. Smith left his daughter $500,000, his wife $600,000, and a local charity $200,000.

What percent of his total did Mr. Smith leave to his daughter? To his wife? To the charity?

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Rates

Sample Problem 1

You are driving, and your speedometer reads 45 mph (that is, 45 miles per hour). How much distance will you cover in one hour?

Follow the steps given below to explain how to understand, to interpret, and then find the answer.

Step 1: Understand and Interpret the Problem

Basically this problem asks you to figure out miles traveled at a given mph rate.

Step 2: Convert the Symbols

Basically, *mph* (miles per hour) = *miles/hour* = *m/h*.

Multiplying *m/h* by *h* gives an answer in *m*–that is, miles.

Step 3: Complete the Computation

Multiply 45 m/h by 1 h:

$$\frac{45 \text{ m}}{\text{h}} \times 1 \text{ h} = 45 \text{ miles}$$

Note that the answer is in *miles* only.

Sample Problem 2

If you are driving 45 mph, how much distance will you cover in *10 minutes*?

1. Convert 10 minutes to hours: 10 minutes = 10/60 hours **or** 1/6 hours.

2. Multiply 45 m/h by 1/6 h:

$$\frac{45 \text{ m}}{\text{h}} \times \frac{1 \text{ h}}{6} = 7.5 \text{ miles}$$

Note that the answer is in *miles* only.

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Rates
(Continued)

Sample Problem 2

Sandra bought 10 pounds of potatoes at $1.99 per pound, 5 pounds of apples at $1.89 per pound, and 7 pounds of oranges at $1.69 per pound. How much money did Sandra pay?

Step 1: Understand and Interpret the Problem

Basically this problem asks you to figure out total cost (dollars) for three different items for sale at different rates (all expressed in dollars per pound).

Step 2: Convert the Symbols

Basically, dollars per pound = $/lb. Multiplying $/lb by lb gives an answer in $–that is, *dollars* only.

Step 3: Complete the Computation

a. Calculate the individual cost of each of the three items:

For the cost of 10 pounds of potatoes at $1.99 per pound, multiply the rate price ($/lb) by 10 lbs:

$1.99/lb x 10 lbs = $19.90

For the cost of 5 pounds of apples at $1.89 per pound, multiply the rate price ($/lb) by 5 lbs:

$1.89/lb x 5 lbs = $9.45

For the cost of 7 pounds of oranges at $1.69 per pound, multiply the rate price ($/lb) by 7 pounds:

$1.69/lb x 7 lbs = $11.83

b. Total the cost of the three items:

$19.90
9.45
11.83
$41.18

Answer: Sandra pays $41.18.

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Rates
(Continued)

Your Turn!

Using what you have learned so far, compute the following problems. Be sure to proceed one step at a time!

1. The Pacific Toy Company has a production line of 90 workers. The "normal" rate of production for each worker on the line is 25 toys per day. Workers receive a bonus of $2.00 per toy for every toy they make over their daily quota.

   At the end of a workweek, how many toys will PTC produce if the workers make no extra toys?

   One week Maria made 3 toys over her quota, and Tom made 5 toys over the quota. How much of a bonus did Maria receive? How much did Tom receive?

2. Citibank Visa's interest rate is 18.87%, and its MasterCard interest rate is 18.95%. John's Visa balance is $101.96 and his MasterCard balance is $98.27.

   Which balance should John pay off first?

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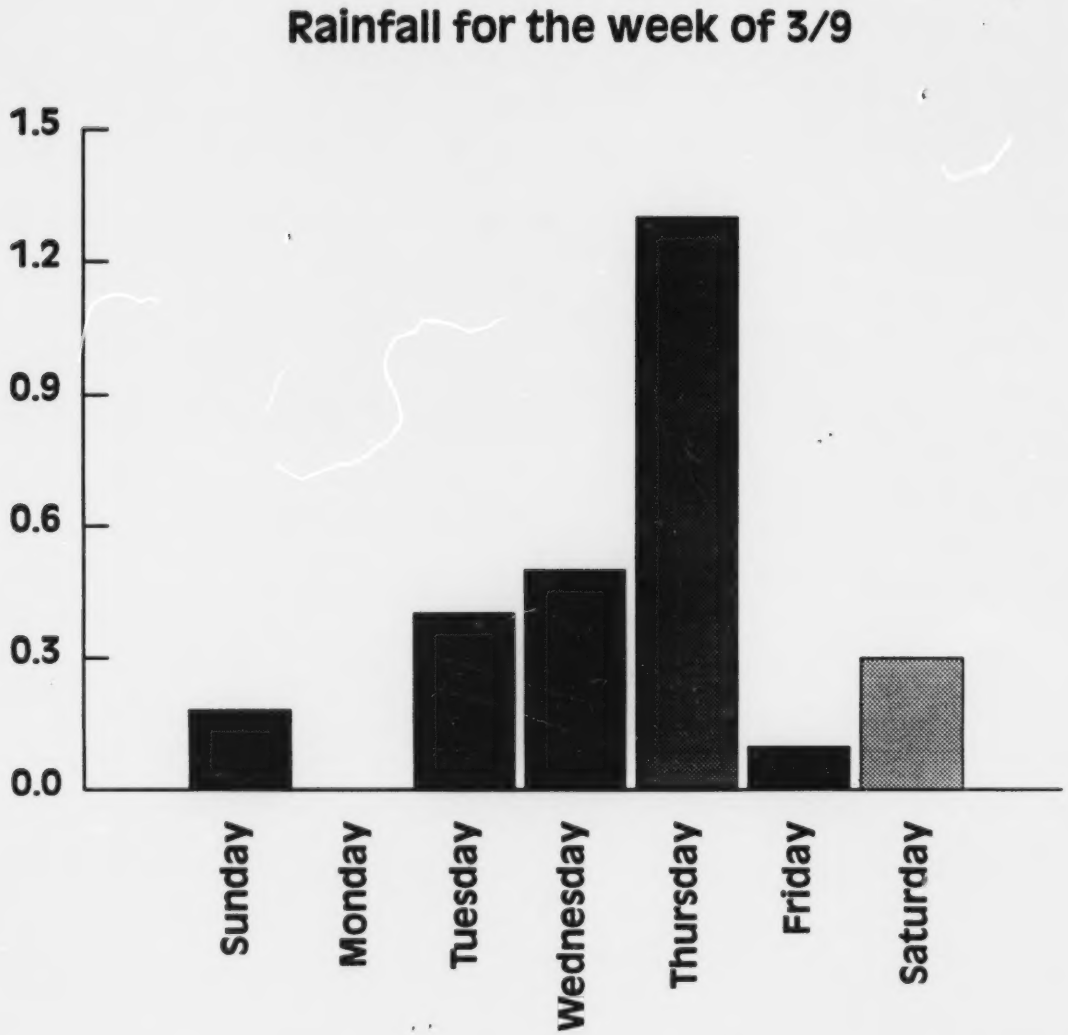

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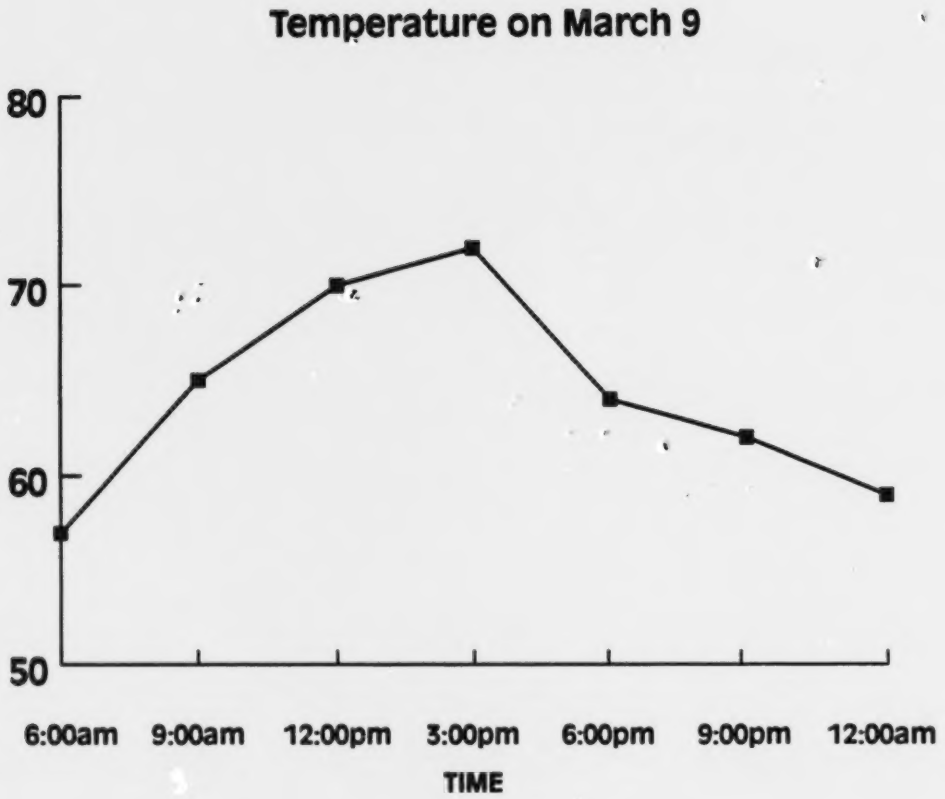

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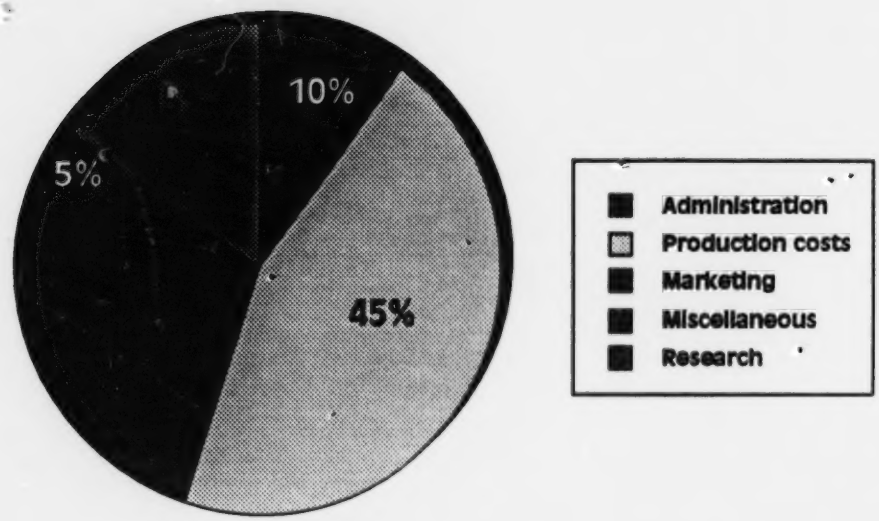
Costs for XYZ, inc.



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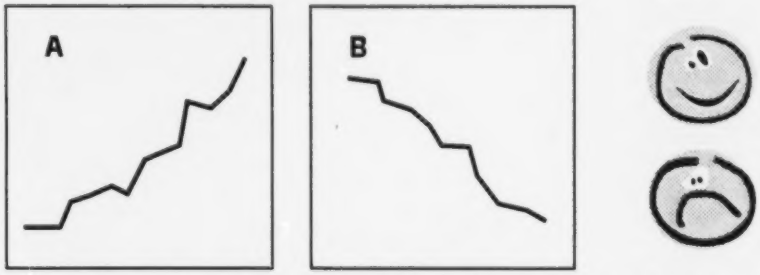
Reading Graphs and Tables

Complete the exercises below.

1. Where will you find graphs and tables?

2. Below there are two pictures of your boss–a happy picture, and an unhappy picture. Looking at the line graphs below, predict how your boss will react to each graph as you read items a through d. use the pictures for your "predictions."



   a. How will your boss react if Graph A shows the trend in profit for your company? How will your boss react to Graph B?

   b. How will your boss react if Graph A shows the number of new customers for your company? How will your boss react to Graph B?

   c. How will your boss react if Graph A shows the number of products returned by customers for your company? How will your boss react to Graph B?

   d. How will your boss react if Graph A shows sales units for your company? How will your boss react to Graph B?

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Reading and Interpreting Tables

This week in Robert's department, Robert made 16 pieces of work, Juan made 20, Cathy made 16, and Kim made 12. Kim is a new worker, so Robert is working with him to provide additional training.

1. Fill in the table to show how many pieces these workers made:

Name of Worker	Number of Pieces Made This Week
Robert	
Juan	
Cathy	
Kim	

2. Which worker made the highest number?

3. Which worker made the lowest number?

4. Why did Kim make only 12 pieces this week?

5. If all the workers put their items together, how many did they make?

6. If Cathy gives Kim four items to help him out, then how many would each of the workers have?

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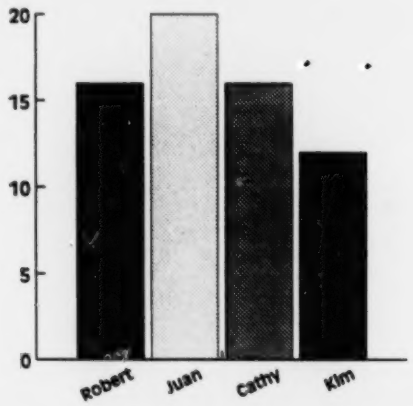
Reading and Interpreting Bar Graphs

Compare the bar graph below with the table in Handout 25.

The graph below shows the same data as the table in the previous handout–but in bar graph form. From the bar graph, can you tell which worker made the most pieces? The least?



1. Fill in the table below using this information: The Juarez family budget this month is as follows: Rent $650, Food $1,250, Auto expenses $120, and Entertainment $85.

Type of Expenses	Amount ($)

2. Draw a bar graph using the information in the table above.

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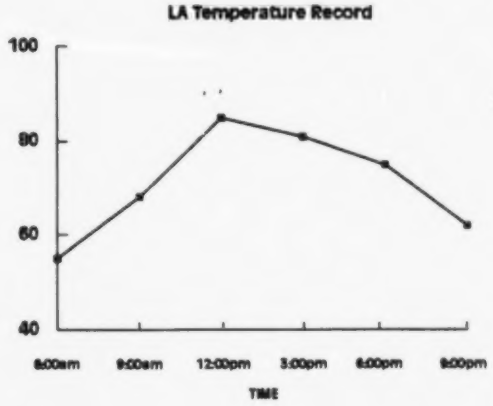
Reading and Interpreting Line Graphs

For one day, the temperatures in Los Angeles were recorded in the following table:

Time of Day	Temperature
6 AM	55
9 AM	68
12 NOON	85
3 PM	81
6 PM	75
9 PM	62

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10 PM?

The line graph below represents of the same data as in the table above. Now answer questions 1 through 4 above using the graph.



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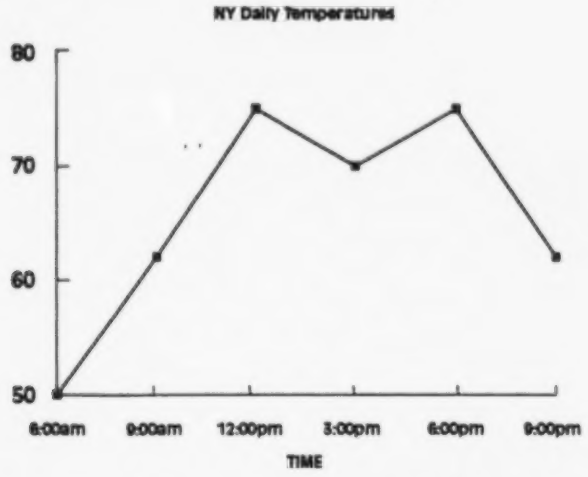
Reading and Interpreting Line Graphs

For one day, the temperatures in New York were recorded as follows: 6AM, 50; 9AM, 62; 12 noon, 75; 3PM, 70; 6PM, 75; and 9PM, 62. Enter this information in the following table:

Time of Day	Temperature

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10PM?

The line graph below shows the same data as in the table above. Now answer questions 1 through 4 above using the graph.



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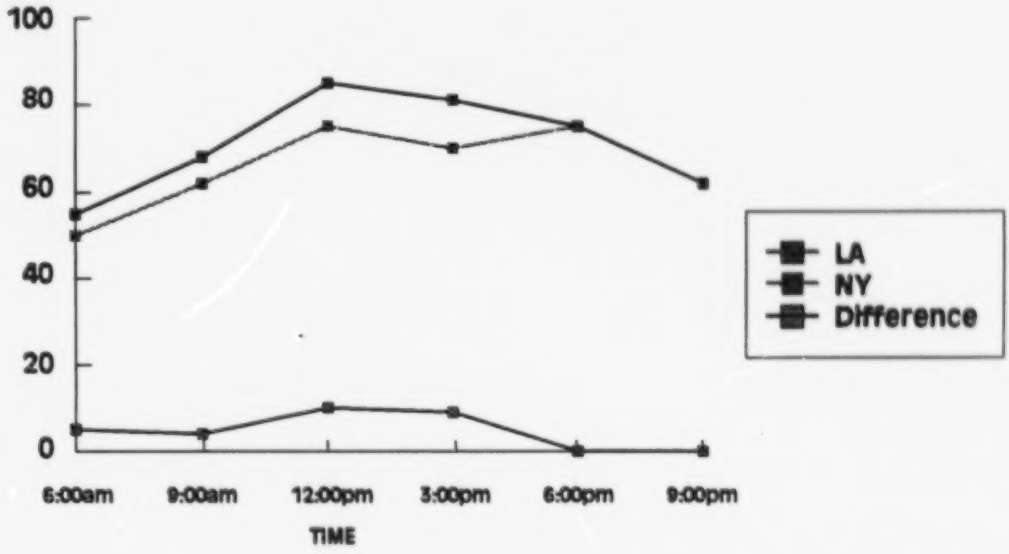
Comparing Line Graphs

The graph below positions the two temperature line graphs side by side, so you can compare temperatures in both cities at the same time. The line at the very bottom of the graph shows the difference in temperature.



1. What were the estimated temperatures at 9 PM (a) in Los Angeles and (b) in New York?

2. What was the difference in the estimated temperatures in the two cities at 9 PM? Does your answer agree with the "difference: in temperature" line at the bottom of the graph?

3. Guess the temperature in each city at 10 PM. Then extend both lines to those points. Can you also extend the "difference" line to 10 PM?

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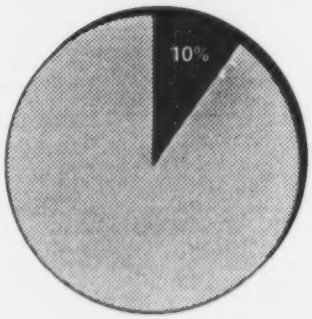
Reading and Interpreting Circle Graphs

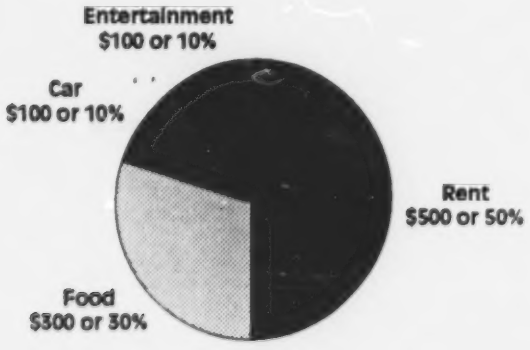
Use the following "measuring device" to estimate how to interpret the pie charts in the questions. The small slice shown is 10% of the entire circle (sometimes we call circle graphs pie charts). So it takes 10 of the small ones make up the entire circle.



1. If you spend 40% on your salary on rent, how many of the small slices above represent your rent expense?

2. If 80% of your company's expenses go to employee wages, how many small slices does wage expense represent?

3. Consider Maria's budget breakdown: Rent $500, Food $300, Car $100, and Entertainment $100. Her total salary is $1,000. How many slices of the circle represent Rent? How many represent Food? Car? Entertainment? Your pie chart should look something like this:



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Building Frequency Tables

Empty your pocket change onto your desk and count it. When your instructor tells you, record the amount on the sheet below:

1. Fill in the table as your classmates tell you the amounts:

Amount of Pocket Money ($)	Tally (III/I)	Frequency (Number)
$ 0.00 - $4.99		
$ 5.00 - $9.99		
$10.00 - $14.99		
$15.00 - $19.99		
$20.00 - $24.99		
$25 00 - $29.99		
$30.00 or more		

2. Which category has the most money?

3. Which category has the lowest number?

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Building Bar Charts

Use the data in Handout 30 to complete the bar chart below. As each person reports how much change she or he has, shade in the appropriate box. The first filled-in box represents the instructor, who claims to be broke! Your finished bar graph should like the graph at the beginning of the lesson.

People						
6						
5						
4						
3						
2						
1	/////					
	0.00-$4.99	$5.00-$9.99	$10.00-$14.99	$15.00-$24.99	$25.00-$29.99	$30 or more

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Exercises on the Balancing Point

Work with a partner to complete the following activities. Your instructor will give you a yardstick or meter stick and some plastic rods and dice for this exercise.

1. Balance the yardstick or meter stick using a pen or pencil (or your index finger). Have the other partner identify where the yardstick balances. Look at the yardstick and read off the precise position. Write this number here:

   The yardstick balance position is at _____ inches

   The meter stick balance position is at _____ centimeters.

2. While one partner continues balancing the stick, the other partner now places one plastic cube at the 1-inch mark of the yardstick AND one plastic cube at the 35-inch mark. If you are using a meter stick, place one cube at the 1-centimeter mark and the second cube at the 99-centimeter mark. Did the balancing point change?

3. Now do the following math:

   a. If you have a yardstick: (1 + 35) /2

   b. If you have a meter stick: (1 + 99) /2

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Exercises on the Balancing Point
(continued)

Continue working in pairs as you complete the following activities.

4. On the yardstick, place one cube at the 1-inch mark and two cubes at the 35-inch mark (on a meter stick, one cube at the 1-centimeter mark and two at the 99-centimeter mark). Is the balancing point the same as before? Explain the change to your partner.

5. To balance the stick once more, where must you place the pencil (or your finger)?

6. Complete the following math:

   a. If you have a yardstick: (1 + 35 + 35)/3

   b. If you have a meter stick: (1 + 99 +99)/3

7. Now switch places with your partner. Experiment placing various numbers of plastic cubes along the stick and observe how the balance changes. Write down the numbers where the sticks balance. Note that the place where the stick balances is called the average.

8. Now assume that in 7 above your findings are as follows:

Number of cubes	1	4	2	3
Location on the stick	5	10	15	30

What is the average? Where does the stick balance?

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Steps in Finding the Average or Mean

To find the average or the mean, follow these steps:

1. Count how many separate numbers you are working with.
2. Add up all the numbers to find the sum.
3. Divide the sum by how many numbers.

Example: Assume you have a list of 20 numbers and they total 180. To find the average or mean of 20 numbers, apply the step above:

1. **Q:** How many numbers? **A:** 20
2. **Q:** What is their sum? **A:** 180
3. **Q:** What is their average or mean? **A:** 180/20 = 9

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Exercises in Finding the Average or Mean

Look at the screen and put the same number of pennies on your own desk as the teacher does. Then answer the following questions.

1. How many pennies does Ken have?

2. How many pennies does Alfred have?

3. How many pennies do Ken and Alfred have together?

4. If Alfred gives Ken one penny, then how many will each have?

5. What is (2 + 4) / 2? (In other words, what is the average or the mean of 2 and 4?)

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Exercises in Finding the Average or Mean
(continued)

6. The answer you got in (5) is called the AVERAGE or the MEAN of the numbers. If we put Ken and Alfred's money together (2+4) = 6, then they have 6 pennies together. If we divide by 2 (one is Ken the other is Alfred) then we get what's called the AVERAGE, or MEAN. What is the AVERAGE or MEAN number of pennies Ken and Alfred have together?

7. Suppose Ken has 7 pennies (place 7 pennies in a row on your own desk) and Alfred has 9 pennies (place 9 pennies in a second row on your own desk). What is the average or mean number of pennies Ken and Alfred now now have?

8. What is the average or mean number of pennies the following three people have?

   Ken has 9 pennies

   Alfredo has 11 pennies

   Tran has 7 pennies

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Exercises in Finding the Average or Mean
(continued)

9. Describe the steps you would take to find the average or the mean of a set of 35 numbers.

   a.

   b.

10. Find the average hourly salary of ten workers who earn $6.70, $7.50, $8.25, $6.00, $10.05, $7.35, $7.00, $6.80, $8.60, and $9.50.

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Additional Exercises in Finding the Average or Mean

Calculate the average or the mean in the following problems.

1. Place all of your pocket change in front of you. Add up all the change you have and tell the instructor your total. Find the average or mean amount of pocket change for the class. Use the space below for your calculation.

2. Find the average height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the average or mean height for the entire class.

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Additional Exercises in Finding the Average or Mean
(continued)

3. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the average number for your group.

4. Choose a partner. Each of you will now make up a story problem that requires you to find the mean or average. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the average amount of money you and your partner spend on food for your families each month?

   b. What is the average amount of money you and your partner spend on rent for your families each month?

   c. What is the average number of hours you and your partner spend driving to work each day?

   Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.

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Finding the Median

1. What is the average of the number of rods your teacher has put on the overhead?

2. Look at the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1 again. How well does the average 3 represent this entire set of numbers? Explain your answer.

3 Sometimes the median, not the mean or average, is a better statistic to use to represent a group of numbers as a whole. To find the median of the numbers listed in the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1, do this:

   a. First arrange the numbers from left to right, like this:

      1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10

   b. Then find the middle number. Since eleven numbers are displayed, the median is the sixth number, 1.

      1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10

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Finding the Median
(continued)

4. Which number better represents the number of years an employee has worked for this company, the average (3) or the median (1)?

5. The 11 people below earn hourly wages as listed:

Fred	Tony	Juan	Peg	Don	Tran	Dave	Pedro	Bob	Kim	Rosa
$7	$20	$5	$5	$5	$5	$20	$5	$6	$5	$5

Find the AVERAGE pay for these 11 workers.

6. To find the median hourly pay for the 11 people above, (a) put the salaries in order, (b) find the middle person, and (c) read that number:

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

What is the median pay?

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Steps in Calculating the Median

To find the median, follow these steps:

1. Rewrite the data from smallest to largest.

2. If there is an *odd number of data*, the middle number is the median. (For example, given 19 separate pieces of data, the median is 9; given 27 pieces, the median is 14; etc.)

3. If there is an *even number of data*, the median position will be between the two middle numbers. The average of these two numbers is the median. (For example, given 14 pieces of data, the median falls between 7 and 8; therefore, the median is 7.5.)

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Calculating the Median

Study these examples before you work the problems:

Example A

Question: What is the median of the numbers 11, 12, and 17?

a. First re-write the numbers from smallest to largest like this: 11, 12, 17.
b. Because there is an odd number of data (3 pieces), find the middle number, which is 12.

Answer: The median is 12.

Example B

Find the median of 12, 17, 11, and 20:

a. Rewrite the numbers from smaller to larger: 11, 12, 17, 20.
b. Now find the average of the two middle numbers: (12+17) / 2 = 14.5

Answer: The median is 14.5.

Now find the median in the following problems!

1. Find the median of the following numbers: 32, 45, 12, 34, 56, 34, 21, 23, 54, 100, 215.

2. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees' tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, *find the median amount of pocket change* for the class. Use the space below for your calculation.

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Calculating the Median
(continued)

3. Find the median height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the median height for the entire class.

4. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the median number for your group.

5. Choose a partner. Each of you will now make up a story problem that requires you to find the median. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the median amount of money you and your partner spend on food for your families each month?

   b. What is the median amount of money you and your partner spend on rent for your families each month?

   c. What is the median number of hours you and your partner spend driving to work each day?

   Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.

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Finding the Mode

In the following set of numbers, which number occurs most often? (The answer is the mode.)

1. Find the mode in the numbers: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1

2. Find the mode of the hourly salary for the people in the table below.

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

3. Find the mode of pocket change for the entire class.

4. Find the mode of the height of the class, including the teacher.

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Finding the Range

Complete the problems below.

1. Take two equal-size plastic rods or two equal coins and place them on a yardstick, one at the 1-inch mark, the other at the 35-inch mark. The **range** is the difference between the highest and the lowest score. In this case, there are only two scores: 35 and 1. What is the difference–the range–between 35 and 1?

2. Now move the plastic rods or coins to the 16-inch mark and the 20-inch mark. Where does the yardstick balance? What is the difference–that is, the range–between 20 and 16?

3. At what other positions can you balance the Cuisinaire rods or coins at the 18-inch mark? What is the range in each case?

4. Find the range of these scores: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1.

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Finding the Range
(continued)

5. Find the range of the hourly salary for the people listed below.

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

6. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, *find the range of pocket change* for the class.

7. Find the range of the height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, *find the range* for the entire class.

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Quality Control in the World Around Us

Follow your instructor's directions for this exercise.

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right"–that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera; the time on your watch; the volume, brightness, or contrast control of your TV set; the speed of your car; the brightness of a lamp; the amount of sugar in your coffee; and the amount of salt in your soup.

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Quality Control in the World Around Us Questions

Consider quality control in your everyday life; then answer the following questions.

1. Name two quality control processes that you use in everyday life.

2. Why do tape and CD manufacturers use sensitive sound equipment to keep the sound "in control"?

3. Why is it important to have a camera in focus before taking a picture?

4. Name two automatic process controls that you use in everyday life.

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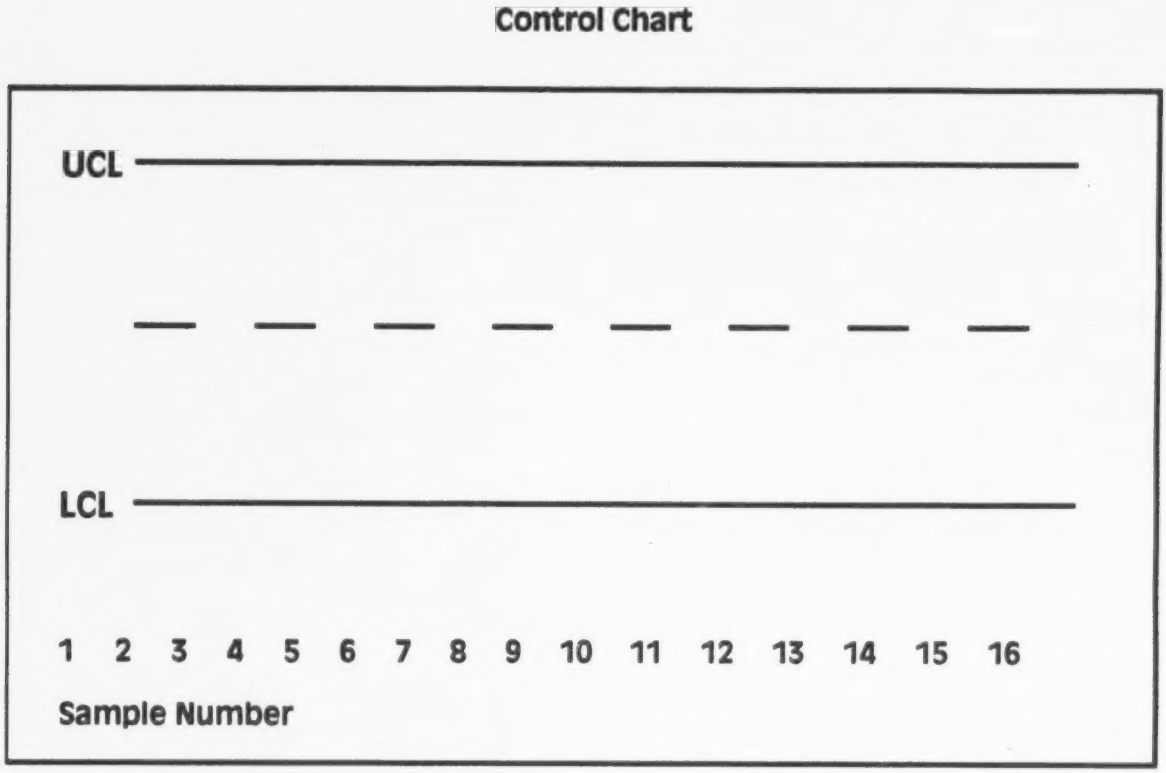
A Sample Control Chart



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A Blank Control Chart Sheet

Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Time, 12:40																
Toss #1																
Toss #2																
Toss #3																
Toss #4																
Toss #5																
Sum																
Average, x																
Range, R																

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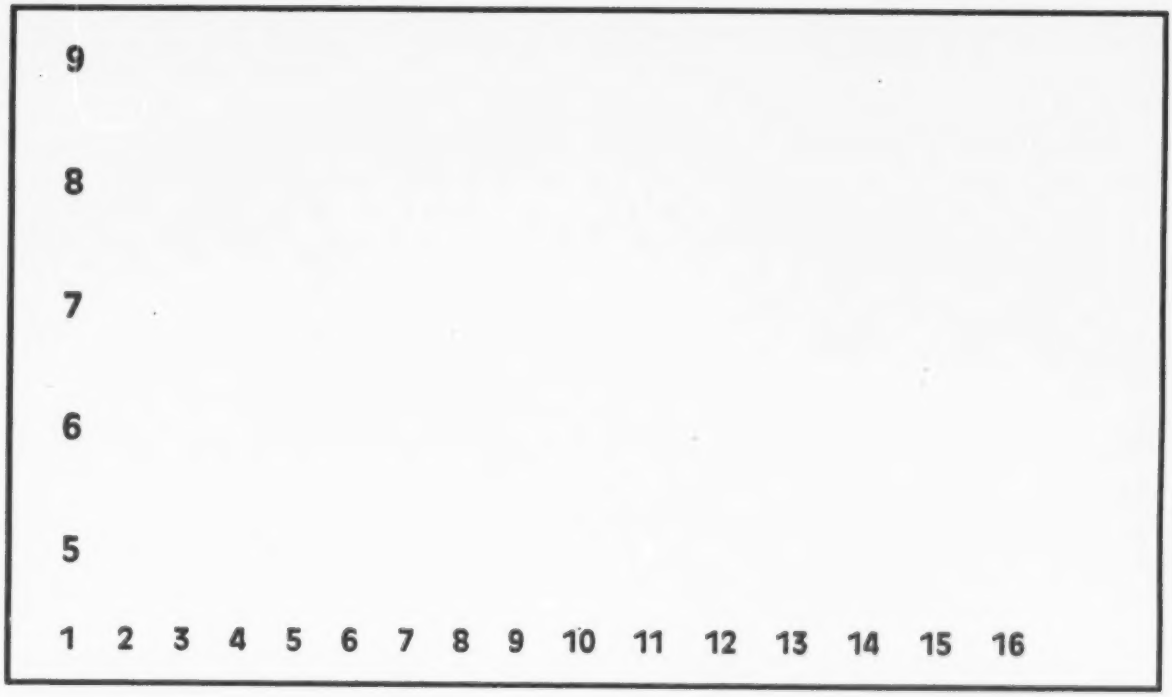
Control Chart



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Getting to Know You

In this exercise you'll get to know your classmates better!

Use the questions below to interview a partner. Then your partner will interview you! At the end of class, you will use the answers on this filled-out worksheet to introduce your partner to the class. Then your partner will introduce you!

First name _____ Last name _____

Nickname ("friends call me...") _____

Three coworkers names _____

_____ _____

Mother's name _____

Father's name _____

Husband's or wife's name _____

Children's names

_____ _____

_____ _____

Favorite foods _____

Favorite singer _____

How did you hear of this company? _____

_____

How long have you worked at this company? _____

Name of supervisor _____

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My Job Is...

Answer the questions below so that you can discuss your job with the group.

1. What is your job title?

2. What department do you work in?

3. What is the name of each part you make or assemble?

4. Where does the part you work on come from? (Which department or coworker?)

5. After you finish your work, where do you send the part you work on?

6. What happens if the part you get is not made correctly? What if you cannot work on it or you have to fix it first? What do you say to the person who sends you the part? Do you send the bad part back?

7. Do you tell your boss when you get a bad part? What do you say?

8. Do you ever have bad parts sent back to you because they weren't made right? About how many parts are returned to you in one week?

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The Company Team

1. What is the name of your company?

2. What is the name of the President of your company?

3. What is the name of the visitor today?

4. What products does your company make?

5. What are these products used for?

6. Have you ever used one of these products yourself?

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Reading and Writing Numbers

In this lesson you will learn (1) to read and write numbers, (2) to add, subtract, multiply, and divide whole numbers, and (3) to take the square root of a number.

1. In our number system, we write numbers so that each **place** tells you *"How many* **ones?"** *"How many* **"tens?"** And so on.

   For example, the number 34 means that you have 3 tens ("30") and 4 ones ("4"). Thus 34 = 30 + 4. We read this number as "Thirty-four." *Thirty* means "3 **tens**" and four means "4 **ones**."

   Note that the first place is "ones" and the second place is "tens." In other words, each *place* represents a specific number value.

2. The system allows you to express larger numbers by *adding more places.* After "tens" comes "hundreds:"

   $$234 = 200 + 30 + 4$$

   Now you have "Two hundred thirty-four." The *Two hundred* means "2 **hundreds**"; the rest is the same as in the example above.

3. And after "hundreds" comes "thousands":

   $$5{,}234 = 5000 + 200 + 30 + 4$$

   Now you have "Five thousand two hundred thirty-four." The *Five thousand* means "5 **thousands**," and the rest is the same as in the example above.

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Your Turn!

Complete the following exercises:

1. Break down the number 67 into tens and ones: 67 = _____ + _____

2. Read the following number aloud: 467

3. Break down 467 into hundreds, tens, and ones: 467 = ___ + ___ + ___

4. Jim weighs 195 pounds (say, "one hundred ninety-five pounds"). He could write his weight like this: 100 + 90 + 5

   How much do **you** weigh? Write your weight in groups: ____ + ____ + ____

5. Now write your weight in the usual way (for example, 195): _____

6. How do you say this number? Write it in words:

   _____

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Addition of Whole Numbers

Complete the following exercises.

1. Use numbers to express O + OO = OOO.

2. Use circles to write the meaning of 8 + 5.

3. What does 12 + 5 mean? Sometimes we write this as:

$$\begin{array}{r} 12 \\ \underline{+\ 5} \end{array}$$

4. Add: 400 + 52 + 19

5. Add: 1,239 + 542 + 95 + 1

6. Now try adding the following:

$2 + 3 =$

$15 + 17 =$

$551 + 22 =$

$702 + 1259 + 55 + 1 =$

Remember: Write the numbers you are adding one below the other, and then add the numbers in each column starting from the right.

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Subtraction of Whole Numbers

Complete the following exercises.

1. Use numbers to express OOO - OO = O

2. Use circles to write the meaning of 8 - 5.

3. What does "12 - 5" mean? Sometimes we write this as:

$$\begin{array}{r} 12 \\ -5 \\ \hline \end{array}$$

4. Subtract: 400 - 52

5. Subtract: 1,239 - 542

6. Now try these:

12 - 3 =

35 - 17 =

551 - 22 =

702 - 259 =

Remember: Write the numbers you are subtracting one below the other, and then subtract the numbers in each column starting from the right.

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Addition and Subtraction Word Problems

As you read the following "word problems," *search for the basic arithmetic information.* Don't be fooled by the extra information! Follow the example:

Example:

Juan Juarez makes $300 per week and his wife Irma makes $150 per week. Together, how much money do Juan and Irma make each week?

Juan makes	$300.00
Irma makes	+150.00
	$450.00

Answer: The Juarez family makes $450.00 each week.

1. I drive a Toyota Corolla. My mother drives a Honda Accord, and my father prefers to drive an Oldsmobile. Our next-door neighbors have a pickup and a Honda Civic. Our upstairs neighbors have two cars.

   How many cars will you see parked in front of our apartment complex when we are all home?

2. Ask the person sitting on your right how many people are sitting to his/her right. Ask the person sitting on your left how many people are sitting to his/her left. Now find *the total number of people sitting in your row.*

3. You have $1,500 in your checking account. Today is payday, and you receive $1,000 in your paycheck. After work, you spend $105 for groceries. After shopping, you decide to deposit the rest of your paycheck into your checking account. How much money do you have in the account after you make your deposit?

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Multiplication of Whole Numbers

Multiplication

1. Use numbers to express
   OOOOOO
   OOOOOO
   OOOOOO

2. Use circles to write the meaning of 8 x 5.

3. What does 12 x 5 mean? Sometimes we write this as

   12
   x 5

4. Multiply 400 x 52:

   400
   x 52

5. Now try the same problem with a calculator. Ask for help if necessary!

6. Multiply using a calculator: 1,239 x 542 x 95 x 2

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Division Problems

Complete the following exercises.

1. Use circles to express 8 / 2

2. Use circles to write the meaning of 8 / 5

3. Divide: 400 / 52 =

4. Divide: 1,239 / 542 =

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Division Word Problems

As you read the following word problems, *search for the basic arithmetic information.* Don't be fooled by the extra information! Follow the example:

Example:

In the Juarez family, Juan makes $300 per week and his wife Irma makes $150 per week. What is the difference between Juans pay and Irmas pay?

Answer: $300 - $150 = $150. The difference in pay is $150.

But we can also say that Juan earns twice as much as Irma–or that he earns 2 times what Irma earns. Note the arithmetic here:

$300/$150 = 2

Thus Juan earns *2 times as much* as Irma earns.

Problems

1. Today is payday and you receive $1,200 in your paycheck. If you spend half of it for groceries and rent, how much of your pay do you have left?

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Square Roots

1. What is the square root of $\sqrt{25}$

2. $\sqrt{25} + \sqrt{36} =$

3. What is the square root of $\sqrt{75}$

4. Wallpaper border needs to be ordered for the Johnson's kitchen. The room is 20' x 15' x 20' x 15'. How much wallpaper border do you need to order?

5. The Juarez family wants to fence in a yard that is exactly square. The area of the yard is 225 square feet. How much fencing is the Juarez family going to need?

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Decimal Numbers

1. What does the number .67 mean?

   .67 = _____ + _____

2. How do you read/write the number .67?

3. What does the number 4.67 mean?

   4.67 = ___ + ___ + ____

4. How do you read/write the number 4.67?

Find your own examples of decimal numbers, and repeat the exercises above.

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Decimal Numbers: Adding and Subtracting

1. What does 1.2 + .5 mean?

$$\begin{array}{r} 1.2 \\ +\ .5 \\ \hline \end{array}$$

2. Add: 4.00 + 5.2 + .19.

$$\begin{array}{r} 4.00 \\ +\ 5.2 \\ +\ .19 \\ \hline \end{array}$$

3. Add: 12. 39 + 54. 2 + .95 + 10

4. What does 1.2 – .5 mean? How do you write this?

5. Subtract: 4.00 – 5.2

6. Subtract: 12.39 – 5.42

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Decimal Numbers: Addition and Subtraction Word Problems

Complete the following exercises. Follow the example.

Example:

Juan Juarez makes $225.50 per week and his wife Irma makes $150.75 per week. How much money do Irma and Juan earn each week?

Juan makes	=	$225.50
Irma makes	=	$150.75
		$376.25

Answer: Irma and Juan make $376.25 each week.

1. You have $1,500.50 in your checking account. Today is payday and you receive $1,245.50 in your paycheck. On your way home, you spend $105.37 for groceries. Then you decide to deposit the rest of your paycheck into your checking account.

   How much money do you have in your account after your deposit?

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Decimal Numbers: Multiplying

Complete the following exercises.

1. 1.2 x 6 means 1.2 + 1.2 + 1.2 + 1.2 + 1.2 + 1.2. The sum is 7.2 (add the numbers to see for yourself!).

   Instead of adding all these numbers, you can multiply two numbers, as follows:

   $$\begin{array}{r} 1.2 \\ \times\ 6 \\ \hline 7.2 \end{array}$$

   As before, the answer is 7.2.

2. Multiply: 4.25 x 52

   $$\begin{array}{r} 4.25 \\ \times\ 52 \\ \hline \end{array}$$

3. Now repeat #2 above but this time use a calculator. If you don't know how to use a calculator, ask someone in your group who does, or ask your instructor. You will learn how to use a calculator in the next worksheet.

   Multiply using your calculator: 4.25 x 52

4. Multiply: 12.39 x 5.42

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Using the Calculator

Use your calculator to solve the following problems. Write the answers after the equals sign.

1. 3 x 4 =
2. 30 x 40 =
3. 300 x 400 =
4. 3,000 x 4,000 =
5. 30,000 x 40,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

Now use your calculator to compute the following divisions. Write your answers after the equals sign.

1. 3/4 =
2. 3/40 =
3. 3/400 =
4. 3/4,000 =
5. 3/40,000 =
6. 3/400,000 =

Can you read the answers that are in scientific notation? If not, ask your instructor for help.

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Decimal Numbers: Dividing

1. Use circles to express 10 ÷ 2.5

2. Use circles to write the meaning of 8 ÷ 5.

3. Divide: 400 ÷ 52 =

4. Divide: 1,239 ÷ 542 =

5. Juan Juarez makes $325.75 per week and his wife Irma makes $155.80 per week. They divide their combined pay into 3 equal parts: one part for rent, one part for food, and one part for all other expenses.

   How much do Irma and Juan spend on rent?

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Percents

1. Pick a plastic square flat and count the number of small squares in it. (Or simply draw a large square on your paper and divide each side into ten parts. Now you have a 10x10 square.)

2. Cover 25 of the small squares with the small dice. (If you are working with pencil and paper, shade in 25 of the small squares.)

3. How many squares are shaded? ___ How many squares total? ____

4. We can write the above in several different ways:

   25 squares per 100 squares
   25 per 100
   25/100
   25%
   .25

   All these statements mean the same thing: namely, *25 squares out of 100 squares.* This is the same as *one-fourth of the large square* **or** 1 *out of four* **or** 1/4 **or** 1 ÷ 4.

   Use your calculator to perform this division: First press 1, then the division sign (÷), then 4, and finally the equals sign (=). Answer: .25 = 25%.

5. Now take the 25 small plastic squares off the flat and put just 10 of them back on the flat. How do we write this new arrangement?

   per _____ or _____/_____ or _____ % or .10

6. Now repeat exercises 1 to 4 by covering the flat (or flats) with the following number of small squares or dice: 5, 7, 50, 90, 99, 100, 125, 200.

7. Can you repeat exercises 1 to 5 by using a circle instead of a flat? Which percents are easy to measure? Which are hard?

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Percents
(Continued)

Use your calculator to answer the following division problems:

1. 20/ 100 =
2. 2/ 10 =
3. 200/ 1,000 =
4. 2,000/ 10,000 =
5. 20,000/ 100,000 =

What pattern do you notice in the above answers?

6. Ken pays $200 per month for food. His pay each month is $1,000. What percent of Ken's pay does he spend for food?

   200 per 1000 **or** 200/1000 **or** _____%

7. If you cover one half of the plastic flats with small dice (squares), then you are covering _____% of the flat.

8. If you pay 7% state sales tax, that means that for every dollar you spend, you have to pay the state ___.

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Percents
(Continued)

To solve word problems involving percents, follow the steps below this sample problem:

Sample Problem

At the grocery store, Mary purchases a carton of milk for $1.59 and a pound of potatoes for $1.99. The sales tax is 7.75%. What is the total that Mary pays for her purchases?

Step-by-Step Solution

Step 1: Understand and Interpret the Problem

This problem has three parts:

a. Add Mary's individual purchases to get a *subtotal* (in dollars).
b. Compute the tax–*in dollars*–that she must pay on her purchases.
c. Add the tax, *in dollars,* to the dollar amount of her purchases (the total will be her *total expense).*

Note that Parts a and c are simple addition. Part b is a percent computation.

Step 2: Add the Individual Purchases

Add Mary's individual purchases–in this case, $1.59 + $1.99 = $3.58. This is the *subtotal,* the number on which you must calculate the sales tax.

Step 3: Compute the Tax in Dollars

a. *Convert the Percent to a Decimal.* To figure out the tax in dollars, you must first convert the sales tax, which is 7.75%, to a decimal number. The 7.75% tax can be expressed as 7.75/100 **or** .0775.
b. *Use the Decimal to Compute the Dollar Amount.* Multiply.0775, the converted percent, by the subtotal: $3.58 x .0775 = $0.277.

Step 4: Add the Dollar Tax to the Dollar Subtotal

Mary's total grocery expense is $3.58 + $0.277 = $3.587, *rounded* to $3.59.

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Percents
(Continued)

Dan's credit card account balances are as follows:

Account	Interest Percent	Current Balance
Citibank Visa	18.94%	$400.01
Discover	14.98%	$398.90
Citibank MasterCard	19.98%	$401.34

Question: If you were Dan, which account would you pay off first?

Question: How much interest will Dan pay on each balance?

To calculate Dan's interest on these balances, convert each interest percent to a decimal, and multiply each balance by that decimal amount:

Visa:	18.94/100 x	$400.1 =
Discover:	14.98/100 x	$398.90 =
MasterCard:	19.98/100 x	$401.34 =

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Percents
(Continued)

Work with a partner to solve the following problem. Ask your instructor for help if necessary.

In his will, Mr. Smith left his daughter $500,000, his wife $600,000, and a local charity $200,000.

What percent of his total did Mr. Smith leave to his daughter? To his wife? To the charity?

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Rates

Sample Problem 1
You are driving, and your speedometer reads 45 mph (that is, 45 miles per hour). How much distance will you cover in one hour?

Follow the steps given below to explain how to understand, to interpret, and then find the answer.

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out miles traveled at a given mph rate.

Step 2: Convert the Symbols
Basically, *mph* (miles per hour) = *miles/hour* = *m/h*.

Multiplying *m/h* by *h* gives an answer in *m*–that is, miles.

Step 3: Complete the Computation
Multiply 45 m/h by 1 h:

$$\frac{45\ \text{m}}{\text{h}} \times 1\ \text{h} = 45\ \textit{miles}$$

Note that the answer is in *miles* only.

Sample Problem 2
If you are driving 45 mph, how much distance will you cover in *10 minutes*?

1. Convert 10 minutes to hours: 10 minutes = 10/60 hours **or** 1/6 hours.

2. Multiply 45 m/h by 1/6 h:

$$\frac{45\ \text{m}}{\text{h}} \times \frac{1\ \text{h}}{6} = 7.5\ \textit{miles}$$

Note that the answer is in *miles* only.

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Rates
(Continued)

Sample Problem 2
Sandra bought 10 pounds of potatoes at $1.99 per pound, 5 pounds of apples at $1.89 per pound, and 7 pounds of oranges at $1.69 per pound. How much money did Sandra pay?

Step 1: Understand and Interpret the Problem
Basically this problem asks you to figure out total cost (dollars) for three different items for sale at different rates (all expressed in dollars per pound).

Step 2: Convert the Symbols
Basically, dollars per pound = $/lb. Multiplying $/lb by lb gives an answer in $–that is, *dollars* only.

Step 3: Complete the Computation

a. Calculate the individual cost of each of the three items:

For the cost of 10 pounds of potatoes at $1.99 per pound, multiply the rate price ($/lb) by 10 lbs:

$1.99/lb x 10 lbs = $19.90

For the cost of 5 pounds of apples at $1.89 per pound, multiply the rate price ($/lb) by 5 lbs:

$1.89/lb x 5 lbs = $9.45

For the cost of 7 pounds of oranges at $1.69 per pound, multiply the rate price ($/lb) by 7 pounds:

$1.69/lb x 7 lbs = $11.83

b. Total the cost of the three items:

$19.90
9.45
11.83
$41.18

Answer: Sandra pays $41.18.

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Rates
(Continued)

Your Turn!

Using what you have learned so far, compute the following problems. Be sure to proceed one step at a time!

1. The Pacific Toy Company has a production line of 90 workers. The "normal" rate of production for each worker on the line is 25 toys per day. Workers receive a bonus of $2.00 per toy for every toy they make over their daily quota.

   At the end of a workweek, how many toys will PTC produce if the workers make no extra toys?

   One week Maria made 3 toys over her quota, and Tom made 5 toys over the quota. How much of a bonus did Maria receive? How much did Tom receive?

2. Citibank Visa's interest rate is 18.87%, and its MasterCard interest rate is 18.95%. John's Visa balance is $101.96 and his MasterCard balance is $98.27.

   Which balance should John pay off first?

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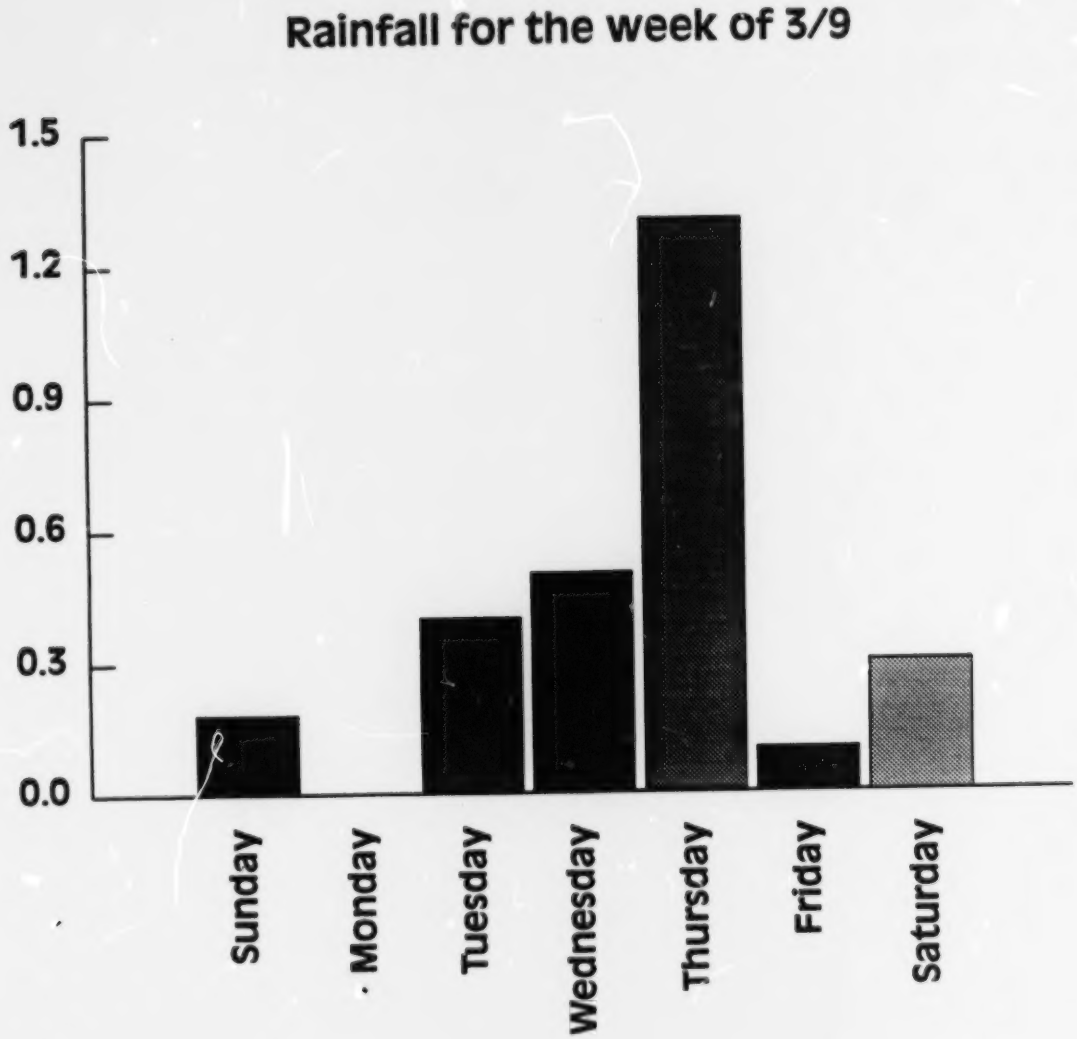

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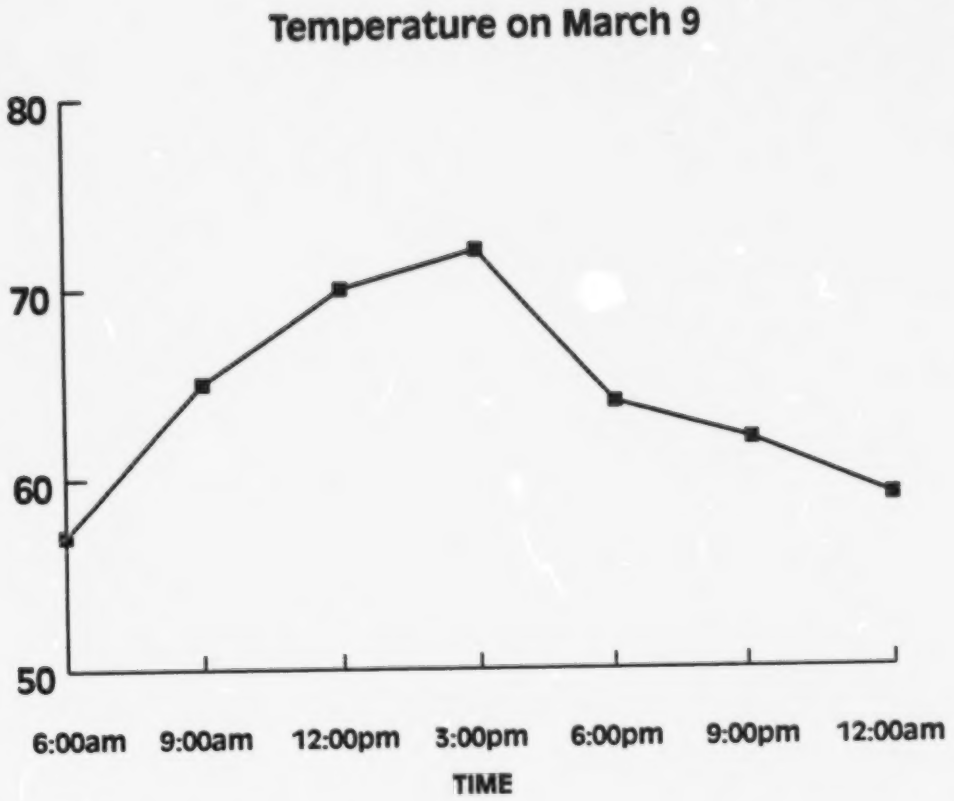

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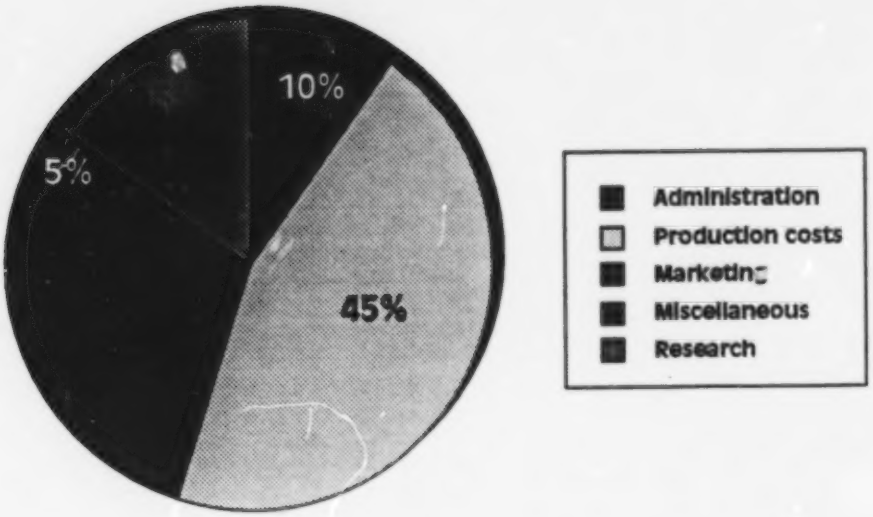
Costs for XYZ, Inc.



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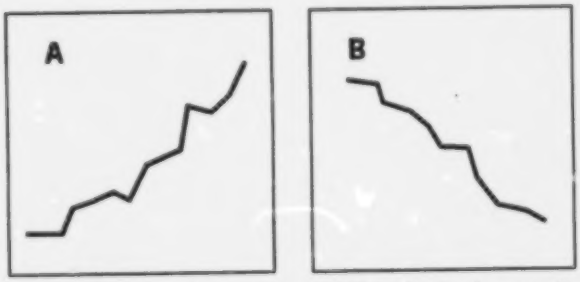
Reading Graphs and Tables

Complete the exercises below.

1. Where will you find graphs and tables?

2. Below there are two pictures of your boss–a happy picture, and an unhappy picture. Looking at the line graphs below, predict how your boss will react to each graph as you read items a through d. use the pictures for your "predictions."



a. How will your boss react if Graph A shows the trend in profit for your company? How will your boss react to Graph B?

b. How will your boss react if Graph A shows the number of new customers for your company? How will your boss react to Graph B?

c. How will your boss react if Graph A shows the number of products returned by customers for your company? How will your boss react to Graph B?

d. How will your boss react if Graph A shows sales units for your company? How will your boss react to Graph B?

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Reading and Interpreting Tables

This week in Robert's department, Robert made 16 pieces of work, Juan made 20, Cathy made 16, and Kim made 12. Kim is a new worker, so Robert is working with him to provide additional training.

1. Fill in the table to show how many pieces these workers made:

Name of Worker	Number of Pieces Made This Week
Robert	
Juan	
Cathy	
Kim	

2. Which worker made the highest number?

3. Which worker made the lowest number?

4. Why did Kim make only 12 pieces this week?

5. If all the workers put their items together, how many did they make?

6. If Cathy gives Kim four items to help him out, then how many would each of the workers have?

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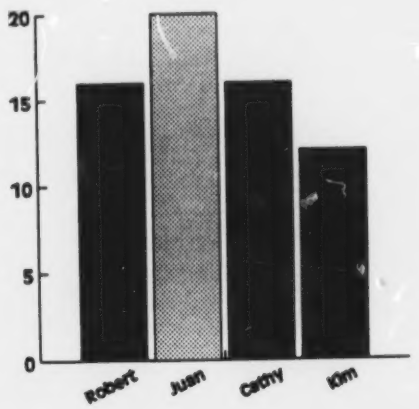
Reading and Interpreting Bar Graphs

Compare the bar graph below with the table in Handout 25.

The graph below shows the same data as the table in the previous handout–but in bar graph form. From the bar graph, can you tell which worker made the most pieces? The least?



1. Fill in the table below using this information: The Juarez family budget this month is as follows: Rent $650, Food $1,250, Auto expenses $120, and Entertainment $85.

Type of Expenses	Amount ($)

2. Draw a bar graph using the information in the table above.

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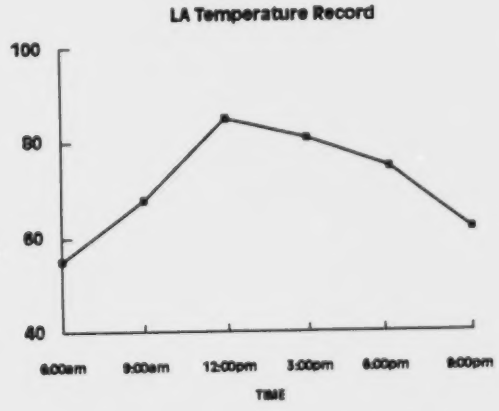
Reading and Interpreting Line Graphs

For one day, the temperatures in Los Angeles were recorded in the following table:

Time of Day	Temperature
6 AM	55
9 AM	68
12 NOON	85
3 PM	81
6 PM	75
9 PM	62

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10 PM?

The line graph below represents of the same data as in the table above. Now answer questions 1 through 4 above using the graph.



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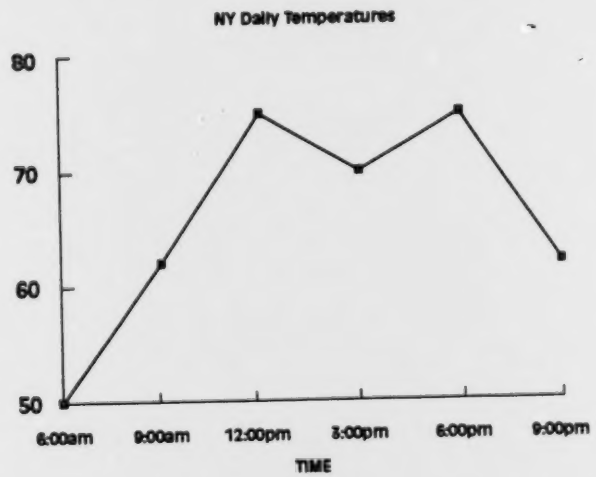
Reading and Interpreting Line Graphs

For one day, the temperatures in New York were recorded as follows: 6AM, 50; 9AM, 62; 12 noon, 75; 3PM, 70; 6PM, 75; and 9PM, 62. Enter this information in the following table:

Time of Day	Temperature

1. What was the highest temperature of the day?
2. What was the lowest temperature?
3. What do you guess the temperature was at 10 AM?
4. What do you guess the temperature was at 10PM?

The line graph below shows the same data as in the table above. Now answer questions 1 through 4 above using the graph.



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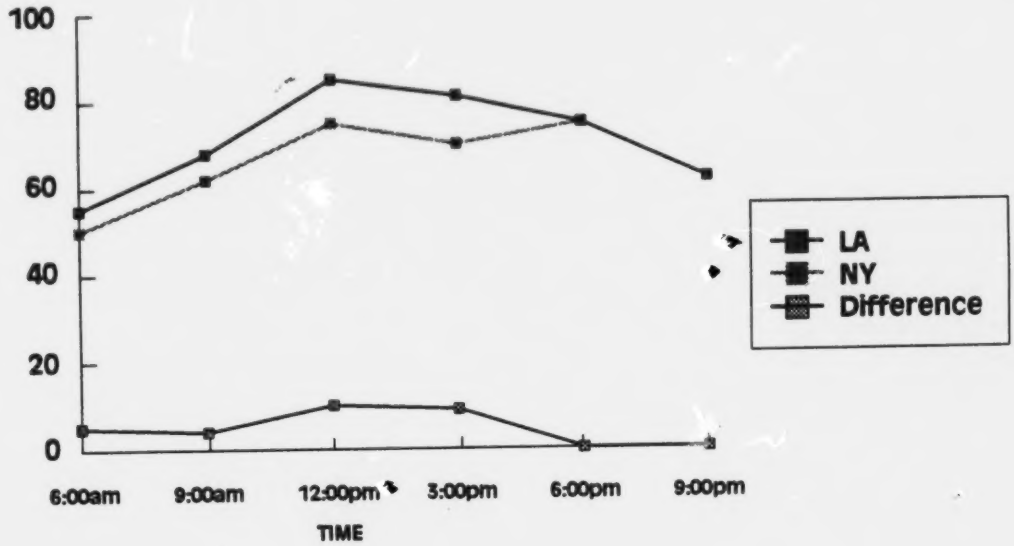
Comparing Line Graphs

The graph below positions the two temperature line graphs side by side, so you can compare temperatures in both cities at the same time. The line at the very bottom of the graph shows the difference in temperature.



1. What were the estimated temperatures at 9 PM (a) in Los Angeles and (b) in New York?

2. What was the difference in the estimated temperatures in the two cities at 9 PM? Does your answer agree with the "difference: in temperature" line at the bottom of the graph?

3. Guess the temperature in each city at 10 PM. Then extend both lines to those points. Can you also extend the "difference" line to 10 PM?

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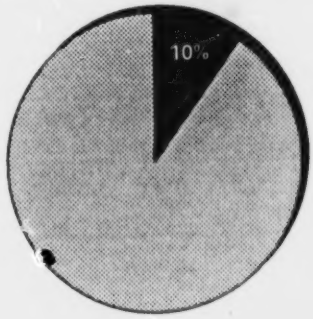
Reading and Interpreting Circle Graphs

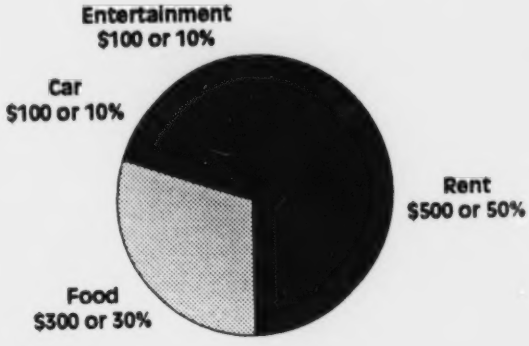
Use the following "measuring device" to estimate how to interpret the pie charts in the questions. The small slice shown is 10% of the entire circle (sometimes we call circle graphs pie charts). So it takes 10 of the small ones make up the entire circle.



1. If you spend 40% on your salary on rent, how many of the small slices above represent your rent expense?

2. If 80% of your company's expenses go to employee wages, how many small slices does wage expense represent?

3. Consider Maria's budget breakdown: Rent $500, Food $300, Car $100, and Entertainment $100. Her total salary is $1,000. How many slices of the circle represent Rent? How many represent Food? Car? Entertainment? Your pie chart should look something like this:



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Building Frequency Tables

Empty your pocket change onto your desk and count it. When your instructor tells you, record the amount on the sheet below:

1. Fill in the table as your classmates tell you the amounts:

Amount of Pocket Money ($)	Tally (III/I)	Frequency (Number)
$ 0.00 - $4.99		
$ 5.00 - $9.99		
$10.00 - $14.99		
$15.00 - $19.99		
$20.00 - $24.99		
$25.00 - $29.99		
$30.00 or more		

2. Which category has the most money?

3. Which category has the lowest number?

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Building Bar Charts

Use the data in Handout 30 to complete the bar chart below. As each person reports how much change she or he has, shade in the appropriate box. The first filled-in box represents the instructor, who claims to be broke! Your finished bar graph should like the graph at the beginning of the lesson.

People						
6						
5						
4						
3						
2						
1	/////					
	0.00-$4.99	$5.00-$9.99	$10.00-$14.99	$15.00-$24.99	$25.00-$29.99	$30 or more

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Exercises on the Balancing Point

Work with a partner to complete the following activities. Your instructor will give you a yardstick or meter stick and some plastic rods and dice for this exercise.

1. Balance the yardstick or meter stick using a pen or pencil (or your index finger). Have the other partner identify where the yardstick balances. Look at the yardstick and read off the precise position. Write this number here:

   The yardstick balance position is at _____ inches

   The meter stick balance position is at _____ centimeters.

2. While one partner continues balancing the stick, the other partner now places one plastic cube at the 1-inch mark of the yardstick AND one plastic cube at the 35-inch mark. If you are using a meter stick, place one cube at the 1-centimeter mark and the second cube at the 99-centimeter mark. Did the balancing point change?

3. Now do the following math:

   a. If you have a yardstick: (1 + 35) /2

   b. If you have a meter stick: (1 + 99) /2

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Exercises on the Balancing Point
(continued)

Continue working in pairs as you complete the following activities.

4. On the yardstick, place one cube at the 1-inch mark and two cubes at the 35-inch mark (on a meter stick, one cube at the 1-centimeter mark and two at the 99-centimeter mark). Is the balancing point the same as before? Explain the change to your partner.

5. To balance the stick once more, where must you place the pencil (or your finger)?

6. Complete the following math:

   a. If you have a yardstick: (1 + 35 + 35)/3

   b. If you have a meter stick: (1 + 99 +99)/3

7. Now switch places with your partner. Experiment placing various numbers of plastic cubes along the stick and observe how the balance changes. Write down the numbers where the sticks balance. Note that the place where the stick balances is called the average.

8. Now assume that in 7 above your findings are as follows:

Number of cubes	1	4	2	3
Location on the stick	5	10	15	30

What is the average? Where does the stick balance?

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Steps in Finding the Average or Mean

To find the average or the mean, follow these steps:

1. Count how many separate numbers you are working with.
2. Add up all the numbers to find the sum.
3. Divide the sum by how many numbers.

Example: Assume you have a list of 20 numbers and they total 180. To find the average or mean of 20 numbers, apply the step above:

1. **Q:** How many numbers?	**A:** 20
2. **Q:** What is their sum?	**A:** 180
3. **Q:** What is their average or mean?	**A:** 180/20 = 9

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Exercises in Finding the Average or Mean

Look at the screen and put the same number of pennies on your own desk as the teacher does. Then answer the following questions.

1. How many pennies does Ken have?

2. How many pennies does Alfred have?

3. How many pennies do Ken and Alfred have together?

4. If Alfred gives Ken one penny, then how many will each have?

5. What is (2 + 4) / 2? (In other words, what is the average or the mean of 2 and 4?)

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Exercises in Finding the Average or Mean
(continued)

6. The answer you got in (5) is called the AVERAGE or the MEAN of the numbers. If we put Ken and Alfred's money together (2+4) = 6, then they have 6 pennies together. If we divide by 2 (one is Ken the other is Alfred) then we get what's called the AVERAGE, or MEAN. What is the AVERAGE or MEAN number of pennies Ken and Alfred have together?

7. Suppose Ken has 7 pennies (place 7 pennies in a row on your own desk) and Alfred has 9 pennies (place 9 pennies in a second row on your own desk). What is the average or mean number of pennies Ken and Alfred now now have?

8. What is the average or mean number of pennies the following three people have?

   Ken has 9 pennies

   Alfredo has 11 pennies

   Tran has 7 pennies

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Exercises in Finding the Average or Mean
(continued)

9. Describe the steps you would take to find the average or the mean of a set of 35 numbers.

   a.

   b.

10. Find the average hourly salary of ten workers who earn $6.70, $7.50, $8.25, $6.00, $10.05, $7.35, $7.00, $6.80, $8.60, and $9.50.

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Additional Exercises in Finding the Average or Mean

Calculate the average or the mean in the following problems.

1. Place all of your pocket change in front of you. Add up all the change you have and tell the instructor your total. Find the average or mean amount of pocket change for the class. Use the space below for your calculation.

2. Find the average height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the average or mean height for the entire class.

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Additional Exercises in Finding the Average or Mean
(continued)

3. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the average number for your group.

4. Choose a partner. Each of you will now make up a story problem that requires you to find the mean or average. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the average amount of money you and your partner spend on food for your families each month?

   b. What is the average amount of money you and your partner spend on rent for your families each month?

   c. What is the average number of hours you and your partner spend driving to work each day?

   Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.

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Finding the Median

1. What is the average of the number of rods your teacher has put on the overhead?

2. Look at the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1 again. How well does the average 3 represent this entire set of numbers? Explain your answer.

3 Sometimes the median, not the mean or average, is a better statistic to use to represent a group of numbers as a whole. To find the median of the numbers listed in the numbers 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1, do this:

   a. First arrange the numbers from left to right, like this:

      1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10

   b. Then find the middle number. Since eleven numbers are displayed, the median is the sixth number, 1.

      1, 1, 1, 1, 1, 1, 1, 2, 2, 10, 10

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Finding the Median
(continued)

4. Which number better represents the number of years an employee has worked for this company, the average (3) or the median (1)?

5. The 11 people below earn hourly wages as listed:

Fred	Tony	Juan	Peg	Don	Tran	Dave	Pedro	Bob	Kim	Rosa
$7	$20	$5	$5	$5	$5	$20	$5	$6	$5	$5

Find the AVERAGE pay for these 11 workers.

6. To find the median hourly pay for the 11 people above, (a) put the salaries in order, (b) find the middle person, and (c) read that number:

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

What is the median pay?

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Steps in Calculating the Median

To find the median, follow these steps:

1. Rewrite the data from smallest to largest.

2. If there is an *odd number of data*, the middle number is the median. (For example, given 19 separate pieces of data, the median is 9; given 27 pieces, the median is 14; etc.)

3. If there is an *even number of data*, the median position will be between the two middle numbers. The average of these two numbers is the median. (For example, given 14 pieces of data, the median falls between 7 and 8; therefore, the median is 7.5.)

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Calculating the Median

Study these examples before you work the problems:

Example A

Question: What is the median of the numbers 11, 12, and 17?

a. First re-write the numbers from smallest to largest like this: 11, 12, 17.
b. Because there is an odd number of data (3 pieces), find the middle number, which is 12.

Answer: The median is 12.

Example B

Find the median of 12, 17, 11, and 20:

a. Rewrite the numbers from smaller to larger: 11, 12, 17, 20.
b. Now find the average of the two middle numbers: (12+17) / 2 = 14.5

Answer: The median is 14.5.

Now find the median in the following problems!

1. Find the median of the following numbers: 32, 45, 12, 34, 56, 34, 21, 23, 54, 100, 215.

2. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, *find the median amount of pocket change* for the class. Use the space below for your calculation.

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Calculating the Median
(continued)

3. Find the median height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, find the median height for the entire class.

4. Find the other employees in your class who do the same job as you do. Together, record the number of pieces each of you worked on yesterday. Find the median number for your group.

5. Choose a partner. Each of you will now make up a story problem that requires you to find the median. Then work together to solve the problems. Your problems should resemble these examples:

   a. What is the median amount of money you and your partner spend on food for your families each month?

   b. What is the median amount of money you and your partner spend on rent for your families each month?

   c. What is the median number of hours you and your partner spend driving to work each day?

   Create similar problems using data from three or four people in your class, or using data from the entire class.

If you don't have enough space here, do your calculations on a separate piece of paper.

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Finding the Mode

In the following set of numbers, which number occurs most often? (The answer is the mode.)

1. Find the mode in the numbers: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1

2. Find the mode of the hourly salary for the people in the table below.

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

3. Find the mode of pocket change for the entire class.

4. Find the mode of the height of the class, including the teacher.

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Finding the Range

Complete the problems below.

1. Take two equal-size plastic rods or two equal coins and place them on a yardstick, one at the 1-inch mark, the other at the 35-inch mark. The **range** is the difference between the highest and the lowest score. In this case, there are only two scores: 35 and 1. What is the difference–the range–between 35 and 1?

2. Now move the plastic rods or coins to the 16-inch mark and the 20-inch mark. Where does the yardstick balance? What is the difference–that is, the range–between 20 and 16?

3. At what other positions can you balance the Cuisinaire rods or coins at the 18-inch mark? What is the range in each case?

4. Find the range of these scores: 2, 10, 1, 1, 1, 1, 10, 1, 2, 1, 1.

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Finding the Range
(continued)

5. Find the range of the hourly salary for the people listed below.

Juan	Rosa	Peg	Don	Tran	Pedro	Kim	Bob	Fred	Tony	Dave
$5	$5	$5	$5	$5	$5	$5	$6	$7	$20	$20

6. Your instructor will ask everyone in the class to place his or her pocket change on the desk. As employees tell their totals, the instructor will write each amount on the board. When the instructor has written the last amount on the board, *find the range of pocket change* for the class.

7. Find the range of the height of your class, including the instructor. Work in pairs to measure everyone's height. After the instructor has written the heights on the board, *find the range* for the entire class.

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Quality Control in the World Around Us

Follow your instructor's directions for this exercise.

Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right."

Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.

Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right"–that is, when the gauge is in the middle. There are many other examples of quality control in everyday life.

You are using quality control when you adjust the focus on your camera; the time on your watch; the volume, brightness, or contrast control of your TV set; the speed of your car; the brightness of a lamp; the amount of sugar in your coffee; and the amount of salt in your soup.

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Quality Control in the World Around Us Questions

Consider quality control in your everyday life; then answer the following questions.

1. Name two quality control processes that you use in everyday life.

2. Why do tape and CD manufacturers use sensitive sound equipment to keep the sound "in control"?

3. Why is it important to have a camera in focus before taking a picture?

4. Name two automatic process controls that you use in everyday life.

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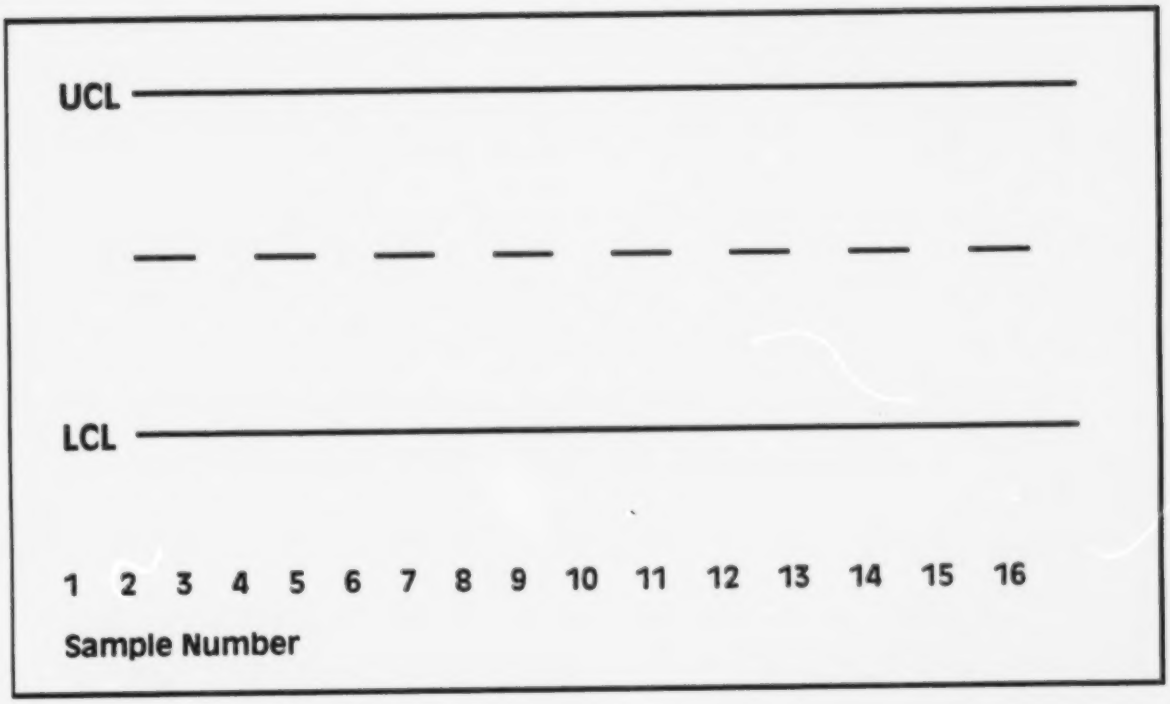
A Sample Control Chart



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A Sample Control Chart Summary Sheet

Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Time, 12:40	:41	:42	:43	:44	:45	:46	:47	:48	:51	:52	:53	:54	:55	:56	:57	:58
Toss #1	9	3	3	3	3	8	4		10	10	2	8	9	11	3	9
Toss #2	3	4	6	7	5	6	5	4	9	11	8	5	2	10	5	7
Toss #3	7	12	7	6	4	7	6	6	8	11	9	11	12	10	6	9
Toss #4	5	4	4	8	6	7	8	6	7	9	10	8	12	4	8	7
Toss #5	8	2	8	10	11	12	2	5	6	6	3	7	11	8	12	4
Sum	32	25	28	34	29	40	25	21	40	47	32	39	46	43	34	36
Average, X	6.4	5	5.6	6.8	5.8	8	5	5.3	8	9.4	6.4	7.8	9.2	8.6	6.8	7.2
Range, R	6	10	5	7	8	6	6	2	4	5	8	6	10	7	9	5

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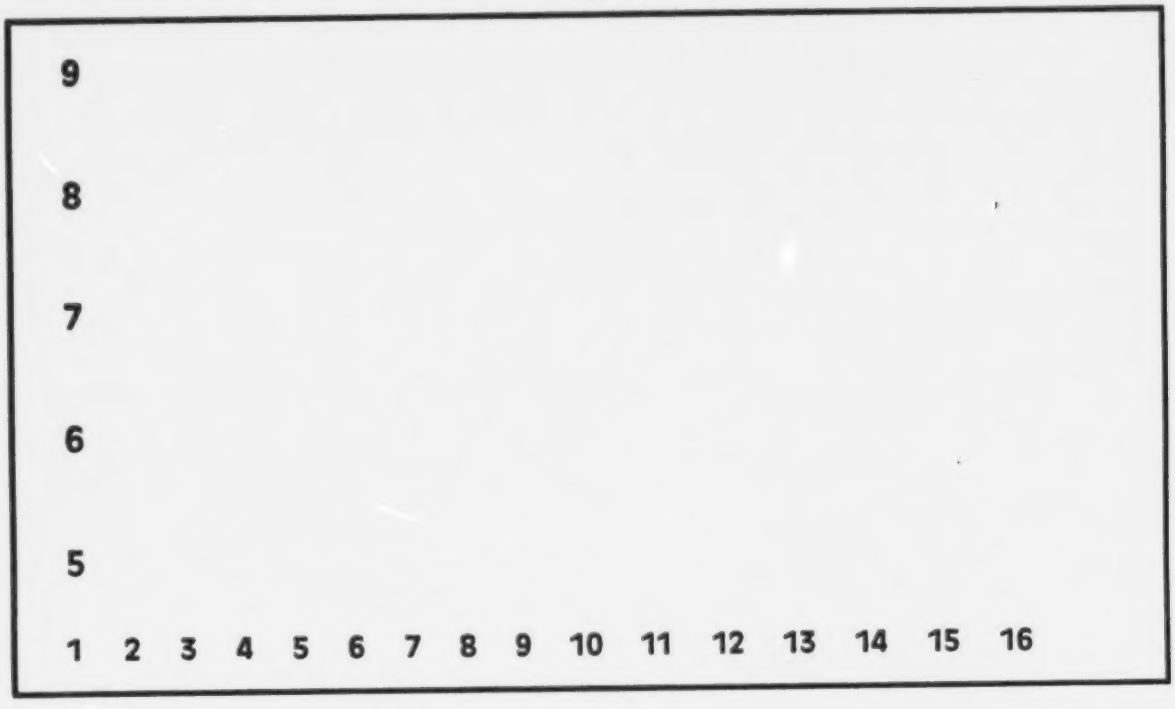
Control Chart



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JobLink

Winning At Work

Math for Statistical Process Control

Supervisor—Making Numbers Count

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▼ **Supervisor Lesson 2:**.....19–31

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Supervisor Lesson 1

▼ Lesson Description

Lesson 1:

Supervisors receive an introduction to the concepts taught in Math for Statistical Process Control. Supervisors are then given a summary of the lessons, and both questions to ask and discussion topics to use as the module is being taught.

Lesson 2:

Supervisors are given a summary of the progress of the class. The rest of the hour focuses on strategies for improving and continuing the skills learned in Math for Statistical Process Control.

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▼ Objectives

By completing this lesson, supervisors will be able to:

1. **Understand** basic concepts taught in module.
2. **Encourage** supervisors to help support learning between classes.

▼ Materials Needed

▼ Hardware

1. Overhead projector
2. Whiteboard/Flip chart
3. Whiteboard Flip chart pens
4. Ball of String
5. Blindfold

▼ Transparencies

"Objectives" (Supervisor Transparency 1)

"Quality Control in the World Around Us" (Supervisor Transparency 2)

▼ Handouts

"Representative handouts from the module"

▼ Classroom Set-up

▼ Total Time: 60 minutes

First Hour

Opening- Large Group	10 min.
First Activity- Large Group	15 min.
Second Activity- Large Group	15 min.
Third Activity- Large Group	10 min.
Ending- Large Group	5 min.

▼ **Key** Hardware | Transparencies | Handouts | Large Group | Small Groups | Discussion | Sign-in Sheet

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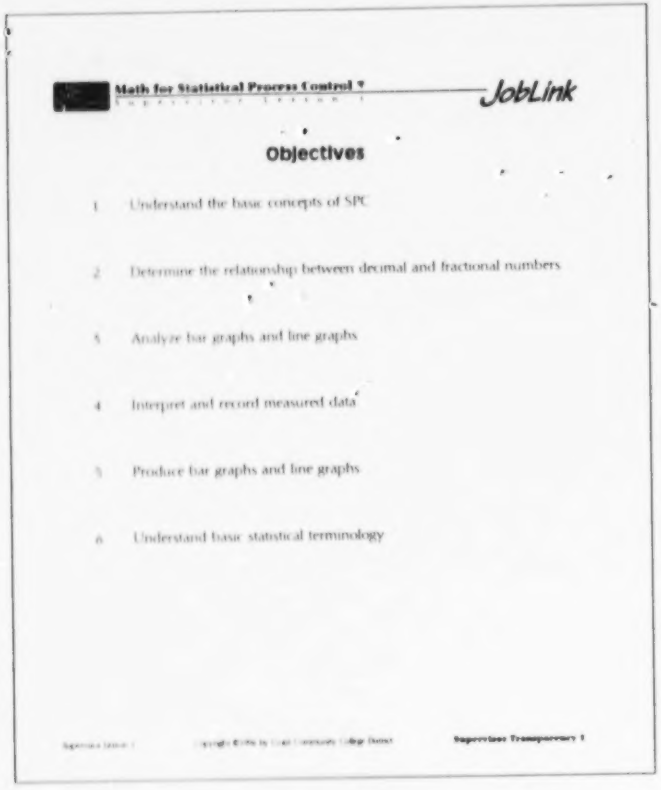
Math for Statistical Process Control ▼
JobLink
Objectives
1 Understand the basic concepts of SPC
2 Determine the relationship between decimal and fractional numbers
3 Analyze bar graphs and line graphs
4 Interpret and record measured data
5 Produce bar graphs and line graphs
6 Understand basic statistical terminology

Supervisor Transparency 1

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▼ Activities

▼ Opening: 15 Minutes

1. **Welcome** everyone and introduce yourself.

2. **Ask** everyone for their names and what department or area they are from.

3. **Explain** that the purpose of the next hour is to familiarize them with the material in the class that their employees will be taking over the next few weeks.

4. **Ask** the supervisors, "What do you want your people to get out of the training?" Write the information you receive on a flipchart or whiteboard.

5. **Explain** that the module covers a lot of the information they are looking for.

6. **Project** the six objectives of the module and **explain** each:

   - Understand the basic concepts of SPC
   - Determine the relationship between decimal and fractional numbers
   - Analyze bar graphs and line graphs
   - Interpret and record measured data
   - Produce bar graphs and line graphs
   - Understand basic statistical terminology

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▼ Activities

▼ First Activity: 15 Minutes

1. **Explain** that everyday we are confronted with examples of math and statistics.

2. **Ask** "Can you give me some every day life examples of when we use addition? Subtraction? Multiplication? Division?"

3. **Say,** "O.K. those are easy. How about decimals? fractions? percentages? rates?"

4. **Say,** "How about mean? Median? Mode? Range?"

5. **Say,** "We are confronted with opportunities to use math on a daily basis. Many employees have a lot of difficulties figuring out how much of a tip to leave a waitress at a restaurant, or how much their credit card company is charging them in interest on their credit card balance. Yet, we think nothing of asking them to read a control chart taped to a machine or even interpret productivity statistics."

6. **Explain** "This class gives an introduction to basic math principles used in Statistical Process Control, ranging from addition and subtraction to percentages and decimals. In addition, we introduce them to some terminology of SPC such as mean, median, range, and quality control."

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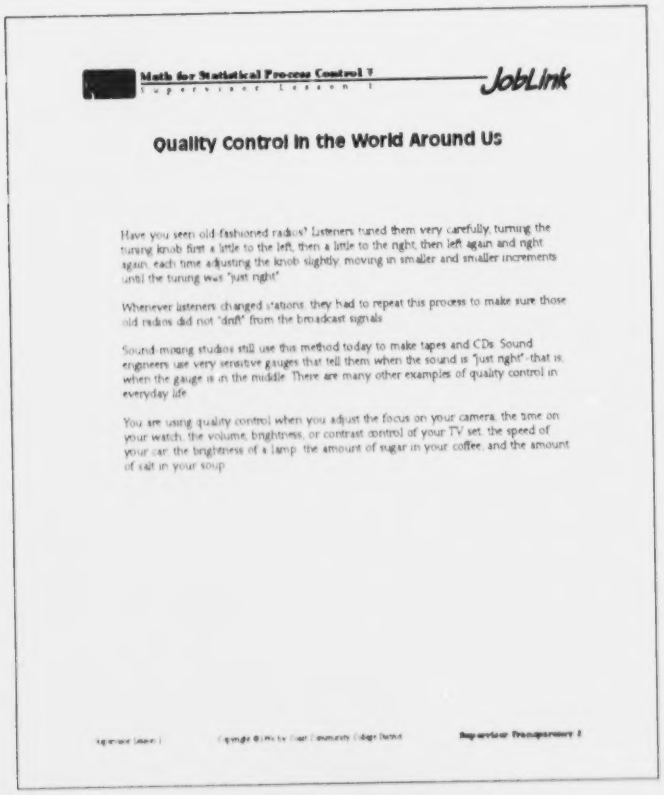
Math for Statistical Process Control 1
Supervisor Lesson 1
JobLink
Quality Control in the World Around Us
Have you seen old-fashioned radios? Listeners tuned them very carefully, turning the tuning knob first a little to the left, then a little to the right, then left again and right again, each time adjusting the knob slightly, moving in smaller and smaller increments until the tuning was "just right"
Whenever listeners changed stations, they had to repeat this process to make sure those old radios did not "drift" from the broadcast signals.
Sound-mixing studios still use this method today to make tapes and CDs. Sound engineers use very sensitive gauges that tell them when the sound is "just right"--that is, when the gauge is on the middle. There are many other examples of quality control in everyday life.
You are using quality control when you adjust the focus on your camera, the time on your watch, the volume, brightness, or contrast control of your TV set, the speed of your car, the brightness of a lamp, the amount of sugar in your coffee, and the amount of salt in your soup.

Supervisor Transparency 2

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▼ Activities

▼ Second Activity: 15 Minutes

1. **Project** "Quality Control in the World Around Us". ***Deliberately*** leave the transparency out of focus. Wait until a supervisor points out the transparency is out of focus; then play with the adjustment knob, deliberately keeping the image out of focus by going slightly past the focus point in each direction several times. Finally, focus on the image properly. Now say to the group, "Adjusting the knob on this projector is an example of ***quality control***".

2. **Read** through transparency. **Explain** that this is a real life example that make the concepts of quality control easy for the employee to understand.

3. **Tell** the supervisors you would like to do a brief demonstration. **Ask** for four volunteers.

4. Have everyone stand up. Have the four volunteers work in pairs. Instruct each pair to hold a long piece of string so as to form a path a little narrower than a normal sidewalk. Make the path as long as the room will allow (say 12 to 20 feet long).

5. **Ask** another volunteer to walk the path; then blindfold the volunteer. **Tell** him or her to walk the length of the path without touching the strings. Instruct the class to yell "Stop! You're out of control!" whenever the blindfolded employee touches the string.

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▼ Activities

▼ Second Activity: (continued)

6. Next, **ask** another volunteer to guide the person to the middle of the path again where the blindfolded volunteer tries again to make it to the other side. When the blindfolded volunteer makes it to the other side, the class cheers and applauds.

7. **Explain** "This is a simple example of a control chart. The idea is to keep a process, such as a manufacturing process, between the acceptable tolerances of quality. The blindfolded person acts as the "product" coming down the assembly line. When the group yells "Stop!" the line is stopped until the problem is fixed, until the blindfold person is placed in the middle of the lane again."

8. **Explain** "This is a simple exercise that makes it easy for the employees to understand what a control chart is."

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▼ Activities

▼ Third Activity: 10 Minutes

1. **Put** together some handouts from the class that you feel are representative of the material covered. Emphasize the handouts that cover information requested by the supervisors.
2. Go over the handouts to give the supervisors a chance to "experience" some of the materials their employees will be covering.
3. Encourage supervisors to send their employees to class with real math problems to solve or charts and graphs to read and interpret.

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▼ Activities

▼ Ending: 5 Minutes

1. **Ask** for questions concerning the module.
2. **Emphasize** the importance of the supervisor's role in the success of the training.
3. **Remind** supervisors of next session.
4. **Say** good-bye.

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Winning At Work

Math for Statistical Process Control

Making Numbers Count

Supervisor Lesson 2

▼ Lesson Description

Supervisors are given a summary of the progress of class. The rest of the hour focuses on strategies for improving and continuing the skills learned in Math for Statistical Process Control.

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▼ Objectives

By completing this lesson, supervisors will be able to:

1. **Review** basic concepts of the Math for Statistical Process Control module.
2. **Reinforce** techniques for increasing the transfer of learning.

▼ Materials Needed

▼ Hardware

1. Overhead projector
2. Whiteboard/Flip chart
3. Whiteboard Flip chart pens

▼ Transparencies

"Objectives" (Supervisor Transparency 1)

"Increasing Your Chance of Success" (Supervisor Transparency 3)

▼ Handouts

"Increasing Your Chance of Success" (Supervisor Handout 1)

▼ Classroom Set-up

▼ Total Time: 60 minutes

Second Hour

Opening- Large Group	15 min.
First Activity- Small Groups	15 min.
Second Activity- Large Group	20 min.
Ending- Large Group	10 min.

▼ Key — Hardware | Transparencies | Handouts | Large Group | Small Groups | Discussion | Sign-in Sheet

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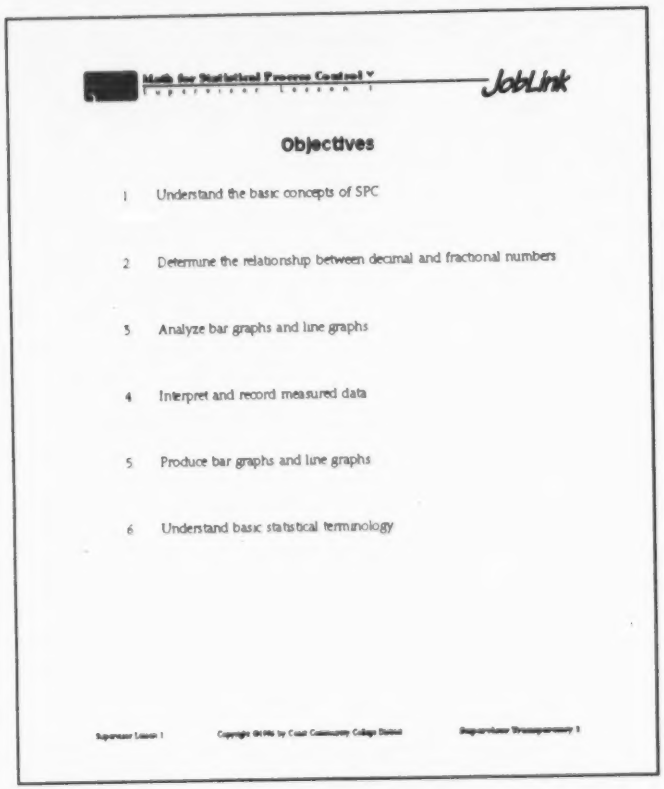
Math for Statistical Process Control ▼
Supervisor Lesson 1
JobLink
Objectives
1 Understand the basic concepts of SPC
2 Determine the relationship between decimal and fractional numbers
3 Analyze bar graphs and line graphs
4 Interpret and record measured data
5 Produce bar graphs and line graphs
6 Understand basic statistical terminology
Supervisor Lesson 1
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Supervisor Transparency 1

Supervisor Transparency 1

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▼ Activities

▼ Opening: 15 Minutes

1. **Welcome** the group back and reintroduce yourself.

2. **Remind** supervisors of the module objectives. **Project** "Objectives" on the overhead.

3. **Explain** "The purpose of today is to give you some techniques to reinforce the skills your employees have learned over the last few weeks."

4. **Ask** the supervisors to give you feedback on the module - specifically, **ask** for feedback about the module and any improvements they have seen.

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▼ Activities

▼ First Activity: 15 Minutes

1. **Direct** the supervisors to get into groups of 3 - 4.
2. **Have** each group come up with as many benefits to doing this module as they can think of.
3. **Have** each group share their answers.

4. **Discuss** the concept of ROI (Return on Investment). **Explain** that this training program translates to actual savings or improvements for their department as demonstrated by their lists.

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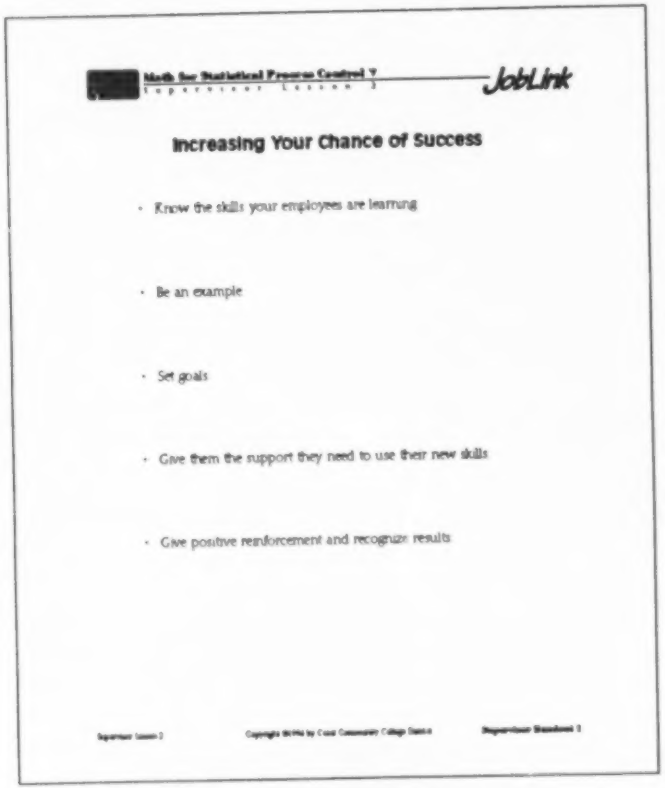
Math for Statistical Process Control ▼
Supervisor Lesson 2
JobLink
Increasing Your Chance of Success
· Know the skills your employees are learning
· Be an example
· Set goals
· Give them the support they need to use their new skills
· Give positive reinforcement and recognize results

Supervisor
Handout 1, Transparency 3

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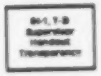
▼ Activities

▼ Second Activity: 20 Minutes

1. **Distribute** "Increasing Your Chance of Success".



2. **Discuss** the items on the handout:

Know the skills your employees are learning.
These supervisor sessions are designed to inform you about what your employees learned in class.

Be an example..
The employees look up to you as an example. The most common phrase we hear in class is, "But my supervisor doesn't do this, so why should I?"

Set goals.
Give the employee something to shoot for. Let them know how you expect to see them use the skills.

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▼ Activities

▼ Second Activity: (continued)

Give them the support they need to use their new skill.
No one likes change. Trying to change our behavior is hard enough without having to fight other factors. Give your employees both a chance and a reason to use their new skills.

Give positive reinforcement and recognize results.
Most importantly recognize employees when you see them using the new skill. There is nothing more powerful.

3. **Ask** "Do you have anything to add to the list?"

4. **Ask** "How can you reinforce the skills learned in Math for Statistical Process Control using the above techniques?"

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Activities

Ending: 10 Minutes

1. **Ask** "What one thing will you do today to reinforce the skills your employees have learned in this module?"

2. **Give** the supervisors a minute to think of something, and then go around the room and have each person share one thing. **Write** their responses on the flip chart or whiteboard.

3. **Re-emphasize** the importance of each supervisor's support and recognition. **Remind** them that their support and recognition will increase the chances that their employees will use the new skills.

4. **Thank** the supervisors for their time and participation.

5. **Say** good-bye.

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Increasing Your Chance of Success

- Know the skills your employees are learning.

- Be an example.

- Set goals.

- Give them the support they need to use their new skills.

- Give positive reinforcement and recognize results.

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Objectives

1. Understand the basic concepts of SPC.

2. Determine the relationship between decimal and fractional numbers.

3. Analyze bar graphs and line graphs.

4. Interpret and record measured data.

5. Produce bar graphs and line graphs.

6. Understand basic statistical terminology.

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Quality Control in the World Around Us

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Increasing the Payoffs of Training

- Know the skills your employees are learning.
- Be an example.
- Set goals.
- Give them the support they need to use their new skills.
- Give positive reinforcement and recognize results.

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